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The scientific publications of the National Museum consist of two series—Proceedings and Bulletins.

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The present volume is the fifty-second of this series.

The Bulletin, publication of which was begun in 1875, is a series of more elaborate papers, issued separately, and, like the Proceedings, based chiefly on the collections of the National Museum.

A quarto form of the Bulletin, known as the "Special Bulletin," has been adopted in a few instances in which a larger page was deemed indispensable.

Since 1902 the volumes of the series known as "Contributions from the National Herbarium," and containing papers relating to the botanical collections of the Museum, have been published as Bulletins.

RICHARD RATHBUN,
*Assistant Secretary, Smithsonian Institution,
 in charge of the United States National Museum.*

JUNE 20, 1917.

TABLE OF CONTENTS.

	Page.
BARTSCH, PAUL. Descriptions of new West American marine mollusks and notes on previously described forms. No. 2193. May 29, 1917 ¹ -----	637-681
New species: <i>Pyramidella</i> (<i>Pharcidella</i>) <i>magdalenensis</i> , <i>Turbonilla</i> (<i>Strioturbonilla</i>) <i>canadensis</i> , T. (S.) <i>montezuma</i> , T. (S.) <i>barkleyensis</i> , T. (S.) <i>santamariana</i> , T. (S.) <i>dore-dona</i> , T. (S.) <i>redondcoensis</i> , T. (S.) <i>schmitti</i> , T. (<i>Pyrgolampros</i>) <i>hannibali</i> , T. (P.) <i>franciscana</i> , T. (P.) <i>hemphilli</i> , T. (P.) <i>pugetensis</i> , T. (P.) <i>tremperi</i> , T. (<i>Pyrgisculus</i>) <i>guilleni</i> , T. (<i>Pyrgiscus</i>) <i>dora</i> , T. (P.) <i>ina</i> , T. (P.) <i>ista</i> , T. (P.) <i>eva</i> , T. (P.) <i>almejasensis</i> , T. (P.) <i>bartolomensis</i> , T. (P.) <i>lamna</i> , T. (P.) <i>mariana</i> , T. (P.) <i>lazaroensis</i> , T. (P.) <i>cortezi</i> , T. (P.) <i>tecalco</i> , T. (P.) <i>corsoensis</i> , T. (P.) <i>baegerti</i> , T. (P.) <i>ulloa</i> , T. (P.) <i>cabrilloi</i> , T. (<i>Cingulina</i>) <i>urdeneta</i> , T. (<i>Mormula</i>) <i>sebastiani</i> , T. (<i>Ugarteia</i>) <i>juani</i> , T. (<i>Mormula</i>) <i>viscainoi</i> , <i>Odostomia</i> (<i>Chrysallida</i>) <i>taraxali</i> , O. (O.) <i>santamariensis</i> , O. (<i>Evalea</i>) <i>valerai</i> , O. (E.) <i>franciscana</i> , O. (E.) <i>willetti</i> , O. (E.) <i>pleioregona</i> , O. (E.) <i>orfordensis</i> , O. (<i>Odostomia</i>) <i>orcutti</i> , <i>Cerithiopsis</i> (<i>Cerithiopsis</i>) <i>charlottensis</i> , C. (C.) <i>grippi</i> , C. (C.) <i>bakeri</i> , C. (C.) <i>helena</i> , <i>Bittium</i> <i>bartolomensis</i> , B. <i>challissae</i> , B. <i>santamariensis</i> , B. <i>santjuanensis</i> , B. <i>serra</i> , <i>Alvania</i> <i>bartolomensis</i> , A. <i>kyskaensis</i> , A. <i>dinora</i> .	
New name: <i>Odostomia</i> (<i>Evalea</i>) <i>andersoni</i> .	
COCKERELL, T. D. A. New Tertiary insects. No. 2181. February 23, 1917 ¹ -----	873-884
New genera: <i>Acrotrichites</i> , <i>Mesomyites</i> , <i>Urortalis</i> , <i>Protoscinis</i> , <i>Taeniturites</i> .	
New species: <i>Rhipidia</i> <i>brodiei</i> , <i>Mongoma</i> <i>cruciferella</i> , <i>Tipula</i> <i>gardneri</i> , <i>Bibio</i> <i>gurentensis</i> , B. <i>oligocenus</i> , <i>Plecia</i> <i>winchesteri</i> , P. <i>explanata</i> , <i>Acrotrichites</i> <i>scopulicornis</i> , <i>Mesomyites</i> <i>concinus</i> , <i>Rhamphomyia</i> <i>hypolitha</i> , <i>Urortalis</i> <i>caudatus</i> , <i>Melleria</i> <i>atavina</i> , <i>Protoscinis</i> <i>perparvus</i> , <i>Anthomyia</i> <i>perseputa</i> , <i>Aeolothrips</i> <i>brodiei</i> , <i>Sisyra</i> <i>disrupta</i> , <i>Taeniturites</i> <i>fortis</i> , <i>Heriades</i> <i>priscus</i> .	

¹ Date of publication.

DALL, WILLIAM HEALEY. Diagnoses of new species of marine bivalve mollusks from the northwest coast of America in the collection of the United States National Museum. No. 2183. December 27, 1916 ¹ -----	393-417
--	---------

New species: *Nucula cardara*, *N. darella*, *N. linki*, *N. quirica*, *N. petriola*, *Leda navisa*, *L. ampliata*, *L. owia*, *L. hogona*, *L. gomphothoe*, *L. lascona*, *L. phenaxia*, *L. spargana*, *Yoldia oleacina*, *Y. secunda*, *Y. beringiana*, *Y. orcia*, *Y. sanesia*, *Y. oecimella*, *Y. capsia*, *Malletia* (*Minormalletia*) *talama*, *M. (Neilo) flora*, *Tindaria californica*, *T. brunnea*, *T. martiniana*, *T. ritteri*, *T. dicojania*, *T. cervola*, *Glycymeris corteziana*, *G. miguellana*, *Limopsis skenia*, *L. akutanica*, *Pteria viridizona*, *Vulsella pacifica*, *Pseudamustum incongruum*, *P. bistriatum*, *Limatula attenuata*, *Modiolus* (*Politus* val.) *pallidulus*, *Dacrydium pacificum*, *Musculus olivaceus*, *Crenella rotunda*, *Dermatomya duttoni*, *D. beringiana*, *D. leonina*, *Cetoconcha malespinae*, *Myonera tillamookensis*, *Cuspidaria apodema*, *Cardiomya balboae*, *Calyptogena elongata*, *Miodontiscus meridionalis*, *Milneria kelseyi*, *Thyasira cygnus*, *T. tricarinata*, *Erycina catalinae*, *E. coronata*, *E. bakeri*, *E. balliana*, *E. chacei*, *E. santarosae*, *Anisodonta? pellucida*, *Rochejortia ferruginosa*, *R. beringensis*, *R. grebnitzskii*, *R. golischi*, *Pseudopythina myactiformis*, *Trigoniocardia oudesia*, *Proto-cardia paziana*, *Cardium dulcinea*, *Psephidia brunnea*, *Macoma quadrana*, *M. truncaria*, *Ervilia californica*, *Sphenia trunculus*, *S. pholadidea*, *Corbula porcella*, *C. kelseyi*, *Panomya beringiana*, *Saxicavella pacifica*.

New varieties: *Septifer bifurcatus*, var. *obsoletus*, *Musculus ridger*, var. *obesus*, *M. n.* var. *protractus*, *Protothaca staminea*, var. *spatiosa*, *Macoma brota*, var. *lipara*, *Panomya artica*, var. *turgida*.

New name: *Macoma brota*.

EASTMAN, CHARLES R. Fossil fishes in the collection of the United States National Museum. No. 2177. February 24, 1917 ¹ -----	235-304
--	---------

New family: *Astraspidae*.

New genus: *Parafundulus*.

New species: *Cladodus aculeatus*, *Dicrenodus texanus*, *Polyrhizodus grandis*, *Harpacanthus procumbens*, *Oracanthus triangularis*, *Lepidotus walcotti*, *Notagodus minutus*, *Parafundulus nevadensis*, *Ameiurus primævus*, *Priscacara dar-tonae*.

FISHER, WALTER K. <i>Trophodiscus</i> , a new sea star from Kamchatka. No. 2180. March 7, 1917 ¹ -----	367-371
---	---------

New genus: *Trophodiscus*.

New species: *Trophodiscus almus*.

FOX, HENRY. Field notes on Virginia orthoptera. No. 2176. March 16, 1917 ¹ -----	199-234
---	---------

¹ Date of publication.

	Page.
GIDLEY, JAMES WILLIAMS. Notice of a new Paleocene mammal, a possible relative of the Titanotheres. No. 2187. February 23, 1917 ¹ -----	431-435
New genus: <i>Titanoides</i> .	
New species: <i>Titanoides primaevus</i> .	
KENNEDY, CLARENCE HAMILTON. Notes on the life history and ecology of the dragonflies (Odonata) of central California and Nevada. No. 2192. May 12, 1917 ¹ -----	483-635
New genera: <i>Zoniagrion</i> , <i>Celaenura</i> , <i>Tanypteryx</i> .	
New species: <i>Celaenura gemina</i> , <i>Ophiogomphus arizonicus</i> , <i>Gomphus donneri</i> .	
New varieties: <i>Agrion aequabile californicum</i> , <i>Ophiogomphus morrisoni nevadensis</i> , <i>O. occidentis californicus</i> .	
LYON, MARCUS WARD, Jr. Mammals collected by Dr. W. L. Abbott on the chain of islands lying off the western coast of Sumatra, with descriptions of twenty-eight new species and subspecies. No. 2188. December 30, 1916 ¹ -----	437-462
New species: <i>Cynopterus babi</i> , <i>Megaderma lasiae</i> , <i>M. siamatis</i> , <i>M. niasense</i> , <i>Myotis abbotti</i> , <i>M. niasensis</i> , <i>Arctictis niasensis</i> , <i>Rhinoecurus incultus</i> , <i>Rattus balmasus</i> , <i>R. pinatus</i> , <i>Pithecus mansalaris</i> , <i>Tragulus pinus</i> .	
New subspecies: <i>Paradozurus hermaphroditus enganus</i> , <i>Sciurus mansalaris balus</i> , <i>Ratufa palliata batuana</i> , <i>Rattus simalurensis lasiae</i> , <i>R. s. babi</i> , <i>R. lingensis danacus</i> , <i>R. l. antucus</i> , <i>R. l. mabalus</i> , <i>R. l. pinacus</i> , <i>R. fremens mansalaris</i> , <i>R. f. tuancus</i> , <i>Pithecus fuscus lasiae</i> , <i>Sus babi tuancus</i> , <i>S. b. enganus</i> , <i>Tragulus napu niasis</i> , <i>T. russulus masae</i> .	
MERRILL, GEORGE P. A new find of meteoric stones near Plainview, Hale County, Texas. No. 2184. March 7, 1917 ¹ -----	419-422
MORRISON, HAROLD. Monograph of the Nearctic hymenoptera of the genus <i>Bracon</i> Fabricius. No. 2178. March 7, 1917 ¹ -----	305-343
New species: <i>Bracon slossonae</i> , <i>B. comstocki</i> , <i>B. montrealensis</i> , <i>B. kelloggi</i> , <i>B. ashmeadi</i> , <i>B. californicus</i> , <i>B. nigrosternum</i> , <i>B. szepligetii</i> , <i>B. virginiensis</i> .	
MYERS, FRANK J. Rotatoria of Los Angeles, California, and vicinity, with descriptions of a new species. No. 2190. February 23, 1917 ¹ -----	473-478
New species: <i>Locane aspasia</i> .	
OBERHOLSER, HARRY C. The birds of Bawean Island, Java Sea. No. 2175. February 8, 1917 ¹ -----	183-198
New species: <i>Stria baweana</i> .	
New subspecies: <i>Spilornis bassus baweanus</i> , <i>Sauropatis chloris cyanescens</i> , <i>Microtarsus atriceps abbotti</i> , <i>Malacocincla abbotti baweana</i> , <i>Gracula javensis baweana</i> , <i>Anthreptes malacensis baweanus</i> .	

¹ Date of publication.

	Page.
PARKER, JOHN BERNARD. A revision of the Bembicine wasps of America north of Mexico. No. 2173. February 10, 1917 ¹ -----	1-155
New genus: <i>Stictiella</i> .	
New Species: <i>Steniolta nigripes</i> , <i>S. albicantia</i> , <i>Stictiella melanosterna</i> , <i>S. callista</i> , <i>S. bituberculata</i> , <i>S. melampous</i> , <i>S. megacera</i> , <i>S. divergens</i> , <i>Bicyrtes annulata</i> , <i>B. gracilis</i> , <i>Bembix arcuata</i> , <i>B. hinet</i> , <i>B. stenobdoma</i> , <i>B. rugosa</i> , <i>B. foxi</i> , <i>B. comata</i> , <i>B. melanaspis</i> , <i>B. helianthopolis</i> , <i>B. latifrons</i> , <i>Microdembex aurata</i> , <i>M. hirsuta</i> .	
RADCLIFFE, LEWIS. Description of a new goby, <i>Garmannia spongicola</i> from North Carolina. No. 2185. February 8, 1917 ¹ -----	423-425
New species: <i>Garmannia spongicola</i> .	
RATHBUN, MARY J. New species of South Dakota cretaceous crabs. No. 2182. February 23, 1917 ¹ -----	385-391
New superfamily: Dakoticancroloideae.	
New family: Dakoticancridae.	
New genus: <i>Dakoticancer</i> .	
New species: <i>Dakoticancer overana</i> , <i>Homolopsis punctata</i> , <i>Campylostoma pierreense</i> .	
SMITH, FRANK. North American earthworms of the family Lumbricidae in the collections of the United States National Museum. No. 2174. February 8, 1917 ¹ -----	157-182
New species: <i>Helodrilus welchi</i> .	
THOMPSON, JOSEPH C. The variation exhibited by <i>Thamnophis ordinoides</i> (Baird and Girard), a garter snake inhabiting the San Francisco Peninsula. No. 2179. March 7, 1917 ¹ -----	345-366
TREADWELL, AARON L. A new species of polychaetous annelid from Panama, with notes on a Hawaiian form. No. 2186. February 8, 1917 ¹ -----	427-430
New species: <i>Phyllodoce panamensis</i> .	
WETMORE, ALEXANDER. On certain secondary sexual characters in the male ruddy duck, <i>Erismatura jamaicensis</i> (Gmelin). No. 2191. February 8, 1917 ¹ -----	479-482
WICKHAM, H. F. New species of fossil beetles from Florissant, Colorado. No. 2189. February 23, 1917 ¹ -----	463-472
New genus: <i>Brachyspathus</i> .	
New species: <i>Platynus insculptipennis</i> , <i>Cratacanthus florissantensis</i> , <i>Harpalus ulomaeformis</i> , <i>H. redivivus</i> , <i>Anatis resurgens</i> , <i>Brachyspathus curiosus</i> , <i>Podabrus cupesoides</i> , <i>Malachius immurus</i> , <i>Vrilletta monstrosa</i> , <i>Spondyliis tertarius</i> , <i>Callidium grandaeorum</i> , <i>Bruchus antaeus</i> , <i>Pandeletellus nudus</i> , <i>Tychius ferox</i> , <i>Baria primalis</i> .	

¹ Date of publication.

LIST OF ILLUSTRATIONS.

PLATES.

	Facing page.
1. <i>Heteracanthus uddeni</i>	304
2. <i>Dinichthys tuberculatus</i> and <i>Sauripterus taylori</i>	304
3. <i>Physonemus gemmatus</i>	304
4. <i>Physonemus gemmatus</i>	304
5. <i>Physonemus arcuatus</i> , <i>P. gemmatus</i> , <i>Ctenacanthus gracillimus</i> , and <i>Oracanthus triangularis</i>	304
6. <i>Edestus heinrichi</i> and <i>Oracanthus vetustus</i>	304
7. <i>Harpacanthus procumbens</i> , <i>Erismacanthus maccoyanus</i> , <i>Dicrenodus</i> <i>texanus</i> , <i>Sauripterus taylori</i> , <i>Oocosteus</i> , species, <i>Ctenacanthus</i> <i>gracillimus</i> , and <i>Psammodus plenis</i>	304
8. <i>Polyrhizodus grandis</i> , <i>Deltodus occidentalis</i> , <i>Polyrhizodus concavus</i> , <i>Dipterus angustus</i> , <i>Polyrhizodus grandis</i> , <i>Chomatodus</i> , species, <i>Cladodus spinosus</i> , and <i>Dinichthys pustulosus</i>	304
9. <i>Elonichthys perpennatus</i> , <i>Chelrodus orbicularis</i> , <i>Elonichthys hyps-</i> <i>plepis</i> , <i>Rhadinichthys gracilis</i> , and <i>Coelacanthus elegans</i>	304
10. <i>Coelacanthus exiguus</i> , <i>Palaeophichthys parvulus</i> , <i>Elonichthys hyps-</i> <i>plepis</i> , <i>Cladodus aculeatus</i> , Arthrodrian plates, and Lepidotid scales.....	304
11. <i>Ceraspis carinata</i> , <i>Ischyrisa mira</i> , and <i>Coelacanthus elegans</i>	304
12. <i>Catopterus gracilis</i> , <i>Semionotus micropterus</i> , <i>Lepidotus walcottii</i> , and <i>Astraspis desiderata</i>	304
13. <i>Catopterus gracilis</i> , and <i>Lepidotus walcottii</i>	304
14. <i>Acanthurus</i> , species, <i>Belonostomus tenuirostris</i> , <i>Belonorhynchus</i> (?) species, and <i>Notagopus minutus</i>	304
15. <i>Platylarchus scaspinosus</i> , <i>Notogoneus osculus</i> , and <i>Semionotus elegans</i>	304
16. <i>Dapedoglossus testis</i> , <i>Parafundulus nevadensis</i> , and <i>Xiphias</i> (?), species.....	304
17. <i>Parafundulus nevadensis</i>	304
18. <i>Cladodus aculeatus</i> , <i>Psephodus legrandensis</i> , <i>Parafundulus nevadensis</i> <i>Leuciscus</i> , and <i>Osmerus</i> (?) species.....	304
19. <i>Amyzon brevipinna</i> , and <i>Cyprinodont</i>	304
20. <i>Ameiurus primaevus</i>	304
21. <i>Mioplosus labracoides</i>	304
22. <i>Platylarchus septemspinosus</i>	304
23. <i>Priscacara dartonae</i>	304
24-27. Morphology of <i>Bracon</i>	344
28. Abactinal surface of <i>Trophodiscus almus</i>	372
29. Actinal surface of <i>Trophodiscus almus</i>	372
30. Ray and disk of <i>Trophodiscus almus</i>	372
31. New fossil insects from the Tertiary.....	384
32-33. New South Dakota cretaceous crabs.....	392
34-35. Meteoric stones from Hale County, Texas.....	422

	Facing page.
36. A new Paleocene mammal from North Dakota.....	436
37-39. Fossil beetles from Florissant, Colorado.....	472
40-41. Rotatoria from Los Angeles, California.....	478
42-47. West American marine mollusks.....	682

TEXT FIGURES.

	Page.
Wings of <i>Stictia carolina</i> Fabricius.—Veins: 1, costal; 2, basal; 3, discoidal; 4, subcostal; 5, median; 6, submedian; 7, submedian cross=transverse median of Cresson; 8, radial; 9, third cubital cross; 10, second cubital cross; 11, first cubital cross; 12, cubitus; 13, first discoidal cross=first recurrent of Cresson; 14, second discoidal cross=second recurrent of Cresson. Cells: A, costal; B, radial; C, first cubital; D, second cubital; E, third cubital; F, median; G, submedian; H, second submedian=second discoidal of Cresson; I, first discoidal; J, second discoidal=third discoidal of Cresson; K, anal; L, basal lobe; M, basal sinus; N, anal sinus; R, retinaculum.....	4
Figs. 1-6.—Wings of 1, <i>Steniolia duplicata</i> ; 2, <i>Stictia carolina</i> ; 3, <i>Stictiella villosa</i> ; 4, <i>Bicyrtes ventralis</i> ; 5, <i>Bembix similans</i> ; 6, <i>Microbembex monodonta</i>	144
Figs. 7-44.—Eighth sternite of 7, <i>Steniolia nigripes</i> , ventral view; 8, <i>S. duplicata</i> , ventral view; 9, <i>S. albicantia</i> , ventral view; 10, <i>S. obliqua</i> , ventral view; 11, <i>S. tibialis</i> , ventral view; 12, <i>S. nigripes</i> , lateral view; 13, <i>S. duplicata</i> , lateral view; 14, <i>S. albicantia</i> , lateral view; 15, <i>S. obliqua</i> , lateral view; 16, <i>S. tibialis</i> , lateral view; Genital stipples of 17-19, <i>Steniolia nigripes</i> ; 20-22, <i>S. duplicata</i> ; 23-25, <i>S. albicantia</i> ; 26-28, <i>S. obliqua</i> ; 29-30, <i>S. tibialis</i> ; Tibia and metatarsus of 31, <i>Steniolia obliqua</i> , male; 32, <i>S. tibialis</i> , male; 33, <i>S. tibialis</i> , female; 34, Seventh tergite, <i>Stictia signata</i> , male; 35, Lateral spine, seventh tergite, <i>S. signata</i> , male; 36, Seventh tergite, <i>S. carolina</i> , male; 37, Lateral spine, seventh tergite, <i>S. carolina</i> , male; Genital stipples, 38-39, <i>S. signata</i> ; 40-41, <i>S. carolina</i> ; 42, Middle femora, <i>S. carolina</i> , male; Antenna, 43, <i>S. signata</i> , male; 44, <i>S. carolina</i> , male.....	145
Figs. 45-85.—Genital stipples of 45-46, <i>Stictiella pictifrons</i> ; 47-48, <i>S. formosa</i> ; 49-50, <i>S. melanosterna</i> ; 51-52, <i>S. serrata</i> ; 53, <i>S. plana</i> ; 54-55, <i>S. tuberculata</i> ; 56, <i>S. callista</i> ; 57-58, <i>S. bituberculata</i> ; 59-60, <i>S. emarginata</i> ; 61-62, <i>S. pulchella</i> ; 63-64, <i>S. speciosa</i> ; 65-66, <i>S. melampous</i> ; 67-68, <i>S. villosa</i> ; 69-70, <i>S. tenuicornis</i> ; 71-72, <i>S. megacera</i> ; 73-74, <i>S. exigua</i> ; 75, <i>S. pulla</i> ; 76-77, <i>S. femorata</i> ; 78-79, <i>S. divergens</i> ; 80, Apical segments, antenna of <i>S. pictifrons</i> , male; 81, Antenna of <i>S. formosa</i> , male; 82, <i>S. melanosterna</i> , male; 83, <i>S. serrata</i> , male; 84, <i>S. plana</i> , male; 85, <i>S. callista</i> , male.....	146
Figs. 86-110.—Antenna of 86, <i>Stictiella bituberculata</i> , male; 87, <i>S. emarginata</i> , male; 88, <i>S. pulchella</i> , male; 89, <i>S. speciosa</i> , male; 90, <i>S. tenuicornis</i> , male; 91, <i>S. megacera</i> , male, basal part; 92, <i>S. exigua</i> , male; 93, <i>S. pulla</i> , male; 94, <i>S. femorata</i> , male; 95, <i>S. divergens</i> , male; 96, Middle tibia and metatarsus of <i>S. pictifrons</i> , male; 97, <i>S. formosa</i> , male; 98, Last segment, left anterior tarsus of <i>S. formosa</i> , male; 99, Middle tibia and metatarsus of <i>S. melanosterna</i> , male; 100, <i>S. serrata</i> , male; 101, <i>S. tuberculata</i> , male; 102, Last segment right anterior tarsus of <i>S. tuberculata</i> , male; 103, Middle tibia and metatarsus of <i>S. callista</i> , male; 104, <i>S. bituberculata</i> , male; 105, <i>S. emarginata</i> , male; 106, <i>S. pulchella</i> , male; 107, <i>S. speciosa</i> , male; 108, <i>S. melampous</i> , male; 109, Middle tibia of <i>S. femorata</i> , male; 110, <i>S. divergens</i> , male.....	147

- Figs. 111-133.—Genital stipples of 111-112, *Bicyrtes jodiens*; 113-114, *B. ventralis*; 115-116, *B. parata*; 117-118, *B. 4-fasciata*; 119-120, *B. variegata*; 121-122, *B. annulata*; 123, *B. gracilis*; 124-125, *B. viduata*; 126-127, *B. insidiatrix*; 128-129, *B. capnoptera*; 130-131, *B. mesillensis*; 132, Middle femur of *B. ventralis*, male; 133, *B. capnoptera*, male; 134, Posterior coxae of *B. jodiens*, female; 135, Ultimate tergite of *B. jodiens*, female; 136, *B. burmeisteri*, female; 137, *B. annulata*, female; 138, *B. capnoptera*, female.----- 148
- Figs. 139-184.—Genital stipples of 139-140, *Bembix arcuata*; 141, *B. U-scripta*; 142-143, *B. cinerea*; 144-145, *B. hinei*; 146-147, *B. nubilipennis*; 148-149, *B. amoena*; 150-151, *B. sayi*; 152-153, *B. belfragei*; 154, *B. stenebdoma*; 155-156, *B. foeti*; 157-158, *B. spinolae*; 159-160, *B. spinolae*, showing variation; 161-162, *B. cameroni*; 163-164, *B. comata*; 165, *B. comata*, showing variation; 166-167, *B. primaestata*; 168, *B. primaestata*, showing variation; 169-170, *B. similans*; 171-172, *B. pruinosa*; 173-174, *B. deutenmulleri*; 175-176, *B. occidentalis*; 177-178, *B. troglodytes*; 179-180, *B. melanaspis*; 181-182, *B. tezana*; 183-184, *B. helianthopolis*.----- 149
- Figs. 185-211.—Antenna of 185, *Bembix arcuata*, male; 186, *B. cinerea*, male; 187, *B. hinei*, male; 188, *B. nubilipennis*, male; 189, *B. amoena*, male; 190, *B. sayi*, male; 191, *B. belfragei*, male; 192, *B. stenebdoma*, male; 193, *B. foeti*, male; 194, *B. spinolae*, male; 195, *B. cameroni*, male; 196, *B. comata*, male; 197, *B. primaestata*, male; 198, *B. similans*, male; 199, *B. pruinosa*, male; 200, *B. deutenmulleri*, male; 201, *B. occidentalis*, male; 202, *B. troglodytes*, male; 203, *B. melanaspis*, male; 204, *B. tezana*, male; 205, *B. helianthopolis*, male; 206, Clypeus and labrum of *B. arcuata*, lateral view; Middle tibia and metatarsus of 207, *B. arcuata*, male; 208, *B. U-scripta*, male; 209, Middle tibia and tarsus of *B. hinei*, male; Middle metatarsus and tibial spur of 210, *B. amoena*, 211, *B. sayi*.----- 150
- Figs. 212-230.—Clypeus and labrum of 212, *Bembix belfragei*, lateral view; 213, Sixth tergite of *B. belfragei*, female; 214, Middle tibia and metatarsus of *B. stenebdoma*; male; 215, Ventral view, sternites 6-8 of *B. stenebdoma*, male; 216, Sixth tergite of *B. rugosa*, female; 217, Clypeus and labrum of *B. rugosa*; Process on second sternite of 218, *Microbembex aurata*, male; 219, *M. monodonta*, male; 220, *M. hirsuta*, male; Genital stipples of 221-222, *M. aurata*; 223-224, *M. hirsuta*; 225-226, *M. monodonta* (Ohio); 227-228, *M. monodonta* (Florida); 229-230, *M. monodonta* (Washington).----- 151
- Dorsomedian shield of *Psammosteus paradoxus* Agassiz, wanting super-ficial ornamentation. Upper Devonian, Neuhausen, Livonia.----- 242
- Pattern of skull-top of Devonian Dipnoans. *A*, *Dipterus valenciennesi*. *B*, *Scaumenacia curta*. In specimens of dipterus the numerous sensory pits are scattered over broad tracts, the general directions of which are indicated by the dotted lines, except in the occipital region where the dotted lines represent shallow grooves. The "parietals," "frontals," etc., are probably not homogenous with those of Tetrapoda. *Dso*, dermosupraoccipital; *Fr*, frontals; *Na*, nasothmoid region; *St*, supratemporal (pterotic); *Tb*, tabulare (epitotic); *Parietal*, pre-parietal ----- 247
- Dimichthys bulla* Upper Devonian, Wildungen, Germany. Restoration of head-shield, slightly modified after Jaekel. *C*, central; *EO*, external occipital; *M*, marginal; *MO*, median occipital; *P*, pineal; *PO*, pre-orbital; *PO*, postorbital; *R*, rostral; *SO*, suborbital.----- 249

	Page.
<i>Dinichthys halmodeus</i> . Marcellus shale (Erian), Livonia Salt Shaft, New York. Restoration of head-shield $\times \frac{1}{2}$ -----	250
<i>Dinognathus ferox</i> . Cleveland Shale (Upper Devonian), Lorain County, Ohio. Reconstruction of the upper dental pavement-----	251
<i>Sauripterus taylori</i> Hall. Catskill, Pennsylvania. Right pectoral limb of type-specimen with parts in their naturally associated position-----	252
<i>Sauripterus taylori</i> Hall. Catskill, Pennsylvania. Restoration of the right pectoral limb, seen from the inner side. The mesopterygial series is represented by the humerus (H), ulna (U) and distally succeeding elements; the preaxial radials (R) are barely represented. The scapulacoracoid, clavicle (cv), supracleithrum (s. cl.), and fin rays are conjecturally restored from analogy with related genera-----	253
<i>Aspidorhynchus acutirostris</i> Agassiz. Upper Jura (lithographic stone), Solenhofen, Bavaria. Lateral aspect of cranium, $\times \frac{1}{2}$ ang, angular; d, dentary; f, frontal; iop, interoperculum; j, jugal; l, lachrymal; m, maxillary; meth, mesethmoid; n, rostrum; oc. sup., supraoccipital; op, operculum; p, parietal; prd, prementary; prf, prefrontal; prm, premaxillary; ptf, postfrontal; prop, preoperculum; sang, surangulare; sop, suboperculum-----	285
<i>Notogonus osculus</i> Cope. Green River Eocene; Twin Creek, Wyoming. Dorsal (A) and lateral (B) aspects of cranium, $\frac{1}{2}$. (After L. Husakof). ANG, angular; AR, articular; D, dentary; E, ethmoid; FR, frontal; HM, hyomandibular; IOP, interoperculum; MtP, metapterygoid; MX, maxilla; OP, operculum; PA, parietal; PFR, prefrontal; PMX, premaxilla; POP, preoperculum; PSP, parasphenoid; PTER, pterotic; Q, quadrate; SANG, surangular; SO, supraoccipital; SOP, suboperculum; SPH, sphenotic; SY, symplectic; VO, vomer; X, cheek-plate-----	289
<i>Garmannia spongicola</i> -----	424
1, <i>Phyllodoce panamensis</i> ; 2, Parapodium, <i>Leodice dubia</i> ; 3, Anterior parapodium; 4, Simple seta; 5, Compound seta-----	429
Lower cheek-teeth of <i>Titanoides primaevus</i> -----	434
Longitudinal section of larynx of male Ruddy duck. b, rima glottidis. c, pulvinus laryngis. d, mouth of air-sac-----	481
Figs. 1-2.— <i>Agriion aequabile californicum</i> . 1. Wings of male. 2. Wings of female-----	485
Figs. 8-10, 14-18.— <i>Lestes stultus</i> . 3-4. Usual coloration. 5-7. Variation in thoracic pattern. 8-10. Appendages of male. 11-13.— <i>Lestes uncatius</i> , appendages of male. 14-18. Nymph-----	486
Figs. 19-32.— <i>Zoniagrion exclamatoris</i> . 19-20. Coloration. 21-23. Venation. 24 and 32. Penis. 25-27. Male, appendages. 28-29. Prothorax. 30. Female, mesostigmal laminae. 31. Segments 9 and 10 of female. 33.— <i>Enallagma carunculatum</i> , basal postcostal vein. 34-35.— <i>Acanthagrion interruptum</i> . 34. Basal postcostal vein. 35. Penis. 36.— <i>Enallagma hageni</i> , basal postcostal vein. 37-38.— <i>Acanthagrion gracile</i> . 37. Basal postcostal vein. 38. Penis. 39.— <i>Amphiagrion saucium</i> , penis. 40.— <i>Enallagma pollutum</i> , penis. 41.— <i>Enallagma civile</i> , penis. 42.— <i>Coenagrion puella</i> , penis-----	491
Figs. 43-52.— <i>Zoniagrion exclamatoris</i> . 43-49. Nymph. 45. Lateral carina. 46. Antenna. 47 and 49. Mentum. 48. Segment 9 of female nymph. 50. Female ovipositing. 51. Eggs in leaf. 52. Egg-----	494
Figs. 53-55.— <i>Celaenura gemina</i> . 53. Male color pattern. 54-55. Female color pattern. 56-58.— <i>Celaenura denticollis</i> . 56. Male color pattern. 57-58. Female color pattern-----	498

Fig. 59.— <i>Celaenura denticollis</i> , pairs of eggs in tissue of grass leaf.	
60–61.— <i>Celaenura denticollis</i> . 60. Pair resting between ovipositions, female with abdomen raised. 61. Female ovipositing.	501
Fig. 62, A and B.— <i>Celaenura gemina</i> , female prothorax. 63–69.— <i>Celaenura denticollis</i> . 63, A and B. Female prothorax. 64–69. Nymph. 66. Mentum. 67. Mental lobe. 68. Segment 9 of female. 69. Caudal gill.	504
Figs. 70–81.— <i>Ischnura penes</i> . 70. <i>I. perparva</i> . 71. <i>I. demorsa</i> . 72. <i>I. verticalis</i> . 73. <i>I. damula</i> . 74. <i>I. erratica</i> . 75. <i>I. ramburii credula</i> . 76. <i>I. bellioothii</i> . 77. <i>I. darberi</i> . 78. <i>I. elegans</i> . 79. <i>I. cervula</i> . 80. <i>I. posita</i> . 81. <i>I. pumilio</i> (genotype). 82.— <i>Ceratura capriola</i> , penis. 83–84.— <i>Ne-halennia irene</i> , penis. 85–91.— <i>Celaenura denticollis</i> . 85. Penis. 86–87. Wings. 88. Female, mesostigmal laminae. 89–91. Male, segment 10. 92–96.— <i>Celaenura gemina</i> . 92. Penis. 93. Female, mesostigmal laminae. 94–96. Male, segment 10.	506
Figs. 97–105.— <i>Tanypterys hageni</i> . 97–98. Color pattern. 99. Labium. 100. Metathoracic tubercle. 101–103. Male, appendages. 104. Female, segments 9 and 10. 105. Penis. 106–114.— <i>Tanypterys pryeri</i> . 106–107. Color pattern. 108. Metathoracic tubercle. 109. Penis. 110. Hamules. 111. Segments 9 and 10 of female. 112–114. Male, appendages.	509
Figs. 115–123.— <i>Tachopteryx thoreyi</i> . 115–116. Color pattern. 117–119. Male, appendages. 120. Segments 9 and 10 of female. 121–123. Nymph. 122. Antenna. 123. Mentum. 124–125.— <i>Tanypterys pryeri</i> , wings.	512
Figs. 126–129.— <i>Tanypterys hageni</i> , wings. 130–132.— <i>Tachopteryx thoreyi</i> , wings.	514
Figs. 133–137.— <i>Cordulegaster diadema</i> . 133–134. Color pattern. 135. Segment 10 of male. 136. Fore leg of male. 137. Segments 9 and 10 of female. 138–143.— <i>Cordulegaster dorsalis</i> . 138–139. Color pattern. 140. Penis and hamules. 141. Segment 10 of male. 142. Segments 9 and 10 of female. 143. Eggs.	518
Fig. 144.—Vulvar lamina and ovipositors (from Rls) in: A. <i>Sympetrum frequens</i> . B. <i>Sympetrum matutinum</i> . C. <i>Sympetrum eroticum</i> , ventral view. D. Same, lateral view. E. <i>Sympetrum cordulegaster</i> . F. <i>Uracis ovipositoris</i> .	519
Figs. 145–146.— <i>Cordulegaster dorsalis</i> . 145. A. Nymph with protective coat of algae. 146. B. Exuvia. 146. Female ovipositing in stream bed.	520
Fig. 147.—Divided median tooth of middle lobe of nymphal labium (from Needham). A. <i>Cordulegaster dorsalis</i> . B. <i>Cordulegaster diadema</i> .	523
Figs. 148–154.— <i>Progomphus borealis</i> . 148. Color pattern. 149. Segments 9 and 10 of female. 150–151. Segment 2 of male. 152–154. Segment 10 of male.	524
Figs. 155–163.— <i>Progomphus borealis</i> , nymph. 157. First leg. 158. Mentum, detail. 159. Head. 160. Mentum. 161. Segments 9 and 10 of male. 162–163. Segments 9 and 10 of female.	528
Figs. 164–169.— <i>Ophiogomphus bison</i> . 164. Color pattern. 165. Hamules. 166–167. Male, appendages. 168. Vulva. 169. Occiput of female. 170–177.— <i>Ophiogomphus morrisoni</i> . 178–185.— <i>Ophiogomphus morrisoni nevadensis</i> .	532
Figs. 186–191.— <i>Ophiogomphus severus montanus</i> . 186. Color pattern. 187. Hamules. 188–189. Male, appendages. 190. Vulva. 191. Female, occiput. 192–197.— <i>Ophiogomphus severus</i> . 198–203.— <i>Ophiogomphus arizonicus</i> .	537

	Page.
Figs. 204-211.— <i>Ophiogomphus occidentis</i> . 204. Color pattern. 205. Hamules. 206-208. Male, appendages. 209. Vulva. 210. Female, occiput. 211. Appendages of a male from Corvallis, Oregon. 212-218.— <i>Ophiogomphus occidentis californicus</i> -----	541
Figs. 219-223.— <i>Ophiogomphus</i> nymphs. 219. <i>O. morrisoni</i> . 220. <i>O. severus</i> . 221. <i>O. morrisoni nevadensis</i> . 222. <i>O. bison</i> . 223. <i>O. occidentis</i> -----	545
Figs. 224-226.— <i>Ophiogomphus bison</i> , nymph. 224. Mentum. 225. Teeth and setae on middle lobe of mentum. 226. Segments 6-10. 227-229.— <i>Ophiogomphus morrisoni</i> . 230-232.— <i>Ophiogomphus severus</i> . 233-235.— <i>Ophiogomphus morrisoni nevadensis</i> . 236-238.— <i>Ophiogomphus occidentis</i> -----	546
Figs. 239-243.— <i>Ophiogomphus</i> , dorsal spines of nymphs. 239. <i>O. bison</i> . 240. <i>O. occidentis</i> . 241. <i>O. morrisoni</i> . 242. <i>O. morrisoni nevadensis</i> . 243. <i>O. severus</i> . 244-246.— <i>Ophiogomphus</i> , lateral fringe on segment 7 of nymph. 244. <i>O. morrisoni nevadensis</i> . 245. <i>O. severus</i> . 246. <i>O. morrisoni</i> -----	548
Figs. 247-249.— <i>Gomphus intricatus</i> . 250-251.— <i>Gomphus olivaceus</i> . 252-253.— <i>Gomphus olivaceus nevadensis</i> -----	551
Figs. 254-262.— <i>Gomphus intricatus</i> . 254. Male, segment 2. 255-257. Male, segment 10. 258. Segments 9-10 of female. 259. Female, occiput. 260-262. Male, left legs-----	553
Figs. 263-271.— <i>Gomphus olivaceus</i> . 263. Male, segment 2. 264-266. Male, segment 10. 267. Vulva. 268. Female, occiput. 269-271. Male, left legs-----	556
Figs. 272-280.— <i>Gomphus sobrinus</i> . 272. Male, segment 2. 273-275. Male, appendages. 276-277. Vulva. 278. Female, occiput. 279-280. Color pattern-----	560
Figs. 281-289.— <i>Gomphus donneri</i> . 281. Male, segment 2. 282-285. Male, appendages. 286. Vulva. 287. Female, occiput. 288-289. Color pattern-----	564
Figs. 290-293, 299-305.— <i>Gomphus sobrinus</i> . 290-293. Male, appendages. 299-305. Color variation. 294-278, 299-308.— <i>Gomphus donneri</i> . 294-298. Male, appendages. 306-308. Color variation-----	566
Figs. 309-310.— <i>Gomphus donneri</i> . 309. Curve representing about 50 specimens. 310. Same curve as 309 reduced to periods of 10. 311-312.— <i>Gomphus sobrinus</i> . 311. Curve representing about 50 specimens. 312. Same curve as 311 reduced to periods of 10-----	569
Fig. 313.— <i>Gomphus sobrinus</i> , variations in the anal area in the male hind wings-----	569
Fig. 314.— <i>Gomphus olivaceus nevadensis</i> , nymph. 315.— <i>Gomphus intricatus</i> , nymph. 316.— <i>Gomphus donneri</i> , nymph. 317.— <i>Gomphus sobrinus</i> , nymph-----	571
Figs. 318-320.— <i>Gomphus olivaceus nevadensis</i> , nymph. 318. Mentum. 319. Mental lobe. 320. Segments 8-10. 321-323.— <i>Gomphus intricatus</i> . 324-325.— <i>Gomphus donneri</i> . 326-328.— <i>Gomphus sobrinus</i> -----	573
Figs. 329-341.— <i>Octogomphus specularis</i> . 329. Segment 2 of male. 330-331. Male, appendages. 332-333. Male, appendages as applied to head of female. 334. Female, segments 9-10. 335. Thoracic color in a Pasadena, Cal., female. 336-339. Variation in color of segment 9 in male. 340-341. Color pattern-----	578

	Page.
Figs. 342-352.— <i>Octogomphus specularis</i> , nymph. 342-346. Nymphs. 347. Head. 348. Mentum. 349. Mental detail. 350. Male, appendages. 351-352. Female, appendages -----	580
Figs. 353-382.— <i>Aeshna interrupta nevadensis</i> . 353-354. Color pattern. 355. Male, appendages. 356-375. Thoracic color variations. 376-379. Nymph. 377. Vulva. 378. Male, appendages. 379. Mentum. 380-381. Segments 9 and 10 of female. 382. Eggs-----	585
Figs. 383-392.— <i>Aeshna walkeri</i> . 383-384. Color pattern. 385. Male, ap- pendages. 386. Hamules. 387-390. Color, segments 9 and 10 of male. 391. Frons. 392. Female, segments 9 and 10. 393-396.— <i>Aeshna pal- mata</i> . 399-402.— <i>Aeshna walkeri</i> , nymph. 400. Mentum. 401. Vulva. 402. Female, appendages. 403.— <i>Aeshna palmata</i> , nymph, female, ap- pendages. 404.— <i>Aeshna constricta</i> , male, appendages-----	590

A REVISION OF THE BEMBICINE WASPS OF AMERICA NORTH OF MEXICO.

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INTRODUCTION.

This revision is based upon a careful study of the collection of Bembicine wasps found in the United States National Museum and of collections in possession of the institutions mentioned below. The writer has also examined the types found in the collections of the American Entomological Society of Philadelphia and of the American Museum of Natural History. Although this work was undertaken as a taxonomic revision of the tribe for North America north of Mexico, it has been thought proper to include a very brief summary of what has been done by other investigators on the biology of several species of these wasps and also to add the results of the writer's own observations.

The Bembicini is a tribe of solitary wasps belonging to the group Fossores or digger wasps. This tribe and the Stizini compose the family Bembicidae. Among these wasps the individuals are either male or female, and the latter constructs her nest alone and provides for her offspring. These nests are burrows dug in the ground, usually in sandy places, and, although each female constructs a burrow for herself, the wasps generally nest in colonies, which may be made up of several species. The most prominent characters distinguishing the Bembicine wasps are the non-folded wings lying flat on the back, the three closed cubital cells of the anterior wing, of which cells the second receives both discoidal cross veins, the absence of a prepectus, the prominently exerted labrum, and the lack of developed ocelli.

The descriptions, both specific and generic, are based upon a study of the specimens at hand. The original descriptions of all previously described species have been carefully studied and the identification of specimens at hand based thereon. In describing new species the type-specimen, whether male or female, is described first, and consequently the description is that of a single individual. This is

followed by a description of the allotype, if available, and by comments upon the variations and peculiarities of the species as shown by paratypes when the new species is described from a number of specimens. In the case of species already described a detailed description of each sex is given whenever both sexes were represented in the collections, and these descriptions, except where noted, are based not upon single individuals but upon the groups of specimens at hand. The drawings of the wings are made from projections of balsam mounts and are all enlarged on the same scale. The figures of all other parts are camera lucida drawings and, save where noted in the explanation of the plates, are drawn exactly on the same scale of magnification. Consequently these drawings show accurately the relative size of similar structures on the various species. All drawings are the work of the writer save Nos. 213 and 216, which are the work of Mr. Noel Deisch.

The generic name *Monedula* Latreille (1802) must be dropped, as Fox has pointed out,¹ since it is preoccupied in ornithology by *Monedula* Hasselquist (1762). Illiger was aware of this prior use of the term and proposed the name *Stictia*² to replace it. The species included in the genus *Monedula*, as given in Handlirsch's monograph, fall into four groups that possess characters sufficiently distinct to warrant, in the writer's judgment, their separation into good genera. To one group the generic name *Stictia* must be applied and this genus is represented by the species *carolina* Fabricius and *signata* Linnaeus. For the second the name of *Stictiella* is proposed, with the species *formosa* Cresson as the type. For the third the subgeneric name *Hemidula* Burmeister must be raised to generic rank with *singularis* Taschenberg as the type. For the fourth a generic name is yet to be proposed and it can not properly be done here since none of the species belonging in this group are found within the region covered by this revision.

The writer desires to acknowledge here his indebtedness to Prof. Herbert Osborn, of the Ohio State University, under whose supervision and direction this work has been done; to the authorities of the United States National Museum for valuable assistance rendered in the course of the work, and for the privilege of laboratory facilities and access to its collections and library. The writer further desires to express his appreciation of the kindness of the following gentlemen in placing at his disposal collections of Bembicine wasps found in the institutions with which they are (or were) respectively connected: Dr. H. T. Fernald, Massachusetts Agricultural College; Prof. George A. Dean, Kansas State Agricultural College; Dr. J. C. Bradley, Cornell University; Dr. S. Graenicher, Public Museum of Milwaukee; Dr. Henry Skinner, American Entomological Society of Philadelphia;

¹ Ent. News, 1901, p. 269.

² Fauna Etrusca, vol. 2.

Mr. Charles Schaeffer, Brooklyn Institute; Mr. F. X. Williams, University of Kansas; Dr. F. E. Lutz, American Museum of Natural History; and Mr. W. T. Davis, Staten Island, New York.

ANATOMY.

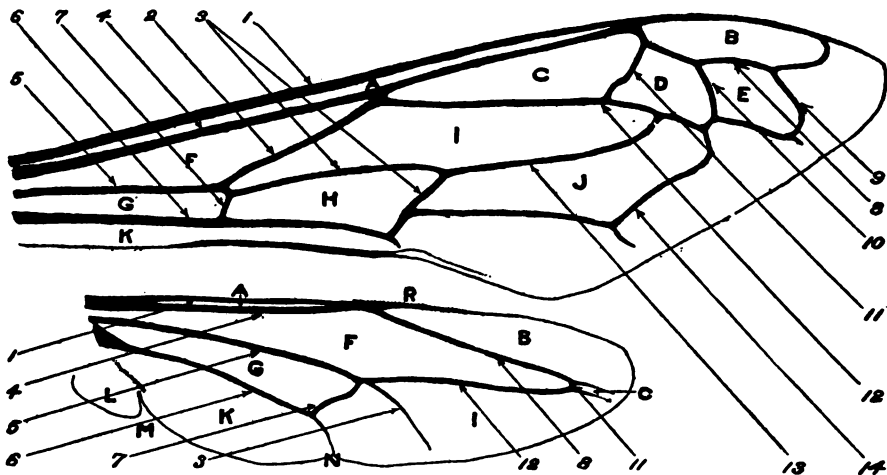
Inasmuch as this work is primarily concerned with a taxonomic revision of the genera and species included, anatomy need be considered only in so far as it has to do with the generic and specific characters used in classification. With this consideration in mind a brief discussion is given below of the anatomy of the Bembicine wasp, such as is deemed sufficient to enable the reader, who is presumed to be familiar with entomological literature, to understand and use intelligently the terms employed in the generic and specific descriptions.

The head is vertical, large, and freely movable upon the prothorax. The compound eyes are large, arched, more or less oval in outline, and naked in all species herein described. Their borders are entire, neither incised nor emarginate. The mouth parts consist of a prominent labrum, a pair of well-developed, pointed mandibles, and a proboscis composed of the highly specialized maxillae and labium. The clypeus is prominent and well defined and varies somewhat in general outline among the genera. The frons from its union with the clypeus, which is marked by an evident suture, extends upward between the compound eyes and joins the vertex, there being no evident dividing line between the two. The antennae are inserted on the frons and are made up of 13 segments in the males and of 12 in the females. The first segment is known as the scape; the remaining segments form the flagellum. The second segment of the antenna, that is, the first segment of the flagellum is frequently called the pedicel, a term not used in my descriptions. The ocelli are not developed in this tribe of hymenoptera and their positions are marked by cicatrices. The anterior cicatrix is found upon the frons while the posterior pair is placed upon the vertex. The occiput is the dorsal part of the head posterior to the eyes and in these wasps is ill defined or wanting, the surface of the head posterior to the eyes being vertical and flat or concave. The temple is that part of the head behind the compound eye visible when the head is viewed from the side.

The prothorax is relatively small; its posterior dorsal border is frequently referred to as the collar and there is a rounded posterior prolongation on either side near the base of the wings to which the term tubercle is applied. The dorsum of the mesothorax is composed of two sclerites of which the anterior is called in my descriptions the scutum, which is equivalent to the term dorsulum of other writers. The posterior sclerite is the scutellum. The dorsum of

the metathorax is the metanotum, more commonly called the post-scutellum. The true first segment of the abdomen is solidly fused with the thorax and is variously termed the median segment, middle segment, or propodeum. In some of the earlier descriptions of species the dorsum of this segment is erroneously called the metanotum.

The term abdomen is applied to that part of the body which is posterior to the median segment and movably attached thereto. Although this is, as a matter of fact, an incorrect use of the term, I have adhered to a practice that has been universal, and consequently the segment that is herein called the first abdominal seg-



WINGS OF *STICTIA CAROLINA* FABRICIUS.—VEINS: 1, COSTAL; 2, BASAL; 3, DISCOIDAL; 4, SUBCOSTAL; 5, MEDIAN; 6, SUBMEDIAN; 7, SUBMEDIAN CROSS—TRANSVERSE MEDIAN OF CRESSON; 8, RADIAL; 9, THIRD CUBITAL CROSS; 10, SECOND CUBITAL CROSS; 11, FIRST CUBITAL CROSS; 12, CUBITUS; 13, FIRST DISCOIDAL CROSS—FIRST RECURRENT OF CRESSON; 14, SECOND DISCOIDAL CROSS—SECOND RECURRENT OF CRESSON. CELLS: A, COSTAL; B, RADIAL; C, FIRST CUBITAL; D, SECOND CUBITAL; E, THIRD CUBITAL; F, MEDIAN; G, SUBMEDIAN; H, SECOND SUBMEDIAN—SECOND DISCOIDAL OF CRESSON; I, FIRST DISCOIDAL; J, SECOND DISCOIDAL—THIRD DISCOIDAL OF CRESSON; K, ANAL; L, BASAL LOBE; M, BASAL SINUS; N, ANAL SINUS; R, RETINACULUM.

ment is in reality the second. Each abdominal segment is composed externally of an arched dorsal plate and a flat ventral plate; the former is termed the tergite, the latter the sternite. The abdomen of the female is composed of six visible segments; that of the male of seven. The eighth segment of the male is concealed and bears the genitalia. The sixth tergite of the female in some species shows a more or less conspicuous lateral ridge at either side and when these ridges are present the area between them is termed the pygidial area or pygidium. The second sternite of the male, or the second and also the sixth, frequently shows a median special structure various in form and variously referred to as a process, tubercle, tooth, or spine.

The wings lie flat when at rest and the general type of venation is shown in the sketch above.

KEY TO GENERA.

1. Anterior ocellar cicatrix circular or elliptical in form, sometimes placed in a pit.... 2.
1. Anterior ocellar cicatrix linear, transverse, straight or curved, in a few species the ocellus not completely obliterated..... 4.
2. Maxillae exceedingly long, when at rest reaching the posterior coxae; maxillary palpi with three segments, labial with one..... *Steniolia*.
2. Maxillae shorter, when at rest folded behind the labrum; maxillary palpi with six segments, labial with four..... 3.
3. Anterior ocellar cicatrix not placed in a pit; seventh tergite of male with lateral spines, eighth sternite ending in a single spine and middle femora with a strong, curved tooth below near the distal end..... *Stictia*.
3. Anterior ocellar cicatrix placed in a pit; seventh tergite of male without lateral spines, middle femora without curved tooth below at distal end, eighth sternite ending in three spines, and in many species bearing a fourth discal spine. *Stictiella*.
4. Posterior surface of median segment concave, its lateral angles prolonged, compressed and wedge-like; maxillary palpi with six segments, labial with four; eighth sternite of male ending in three spines..... *Bicyrtes*.
4. Posterior surface of median segment flat or convex, its lateral angles rounded; palpi otherwise; eighth sternite of male ending in a single spine..... 5.
5. Mandibles dentate; apical end of radial cell of anterior wing on costal border; maxillary palpi with four segments, labial with two..... *Bembix*.
5. Mandibles not dentate; apical end of radial cell of anterior wing not on costal border; maxillary palpi with three segments, labial with one..... *Microbembex*.

Genus STENIOLIA Say.

Steniolia SAY, Bost. Journ. Nat. Hist., vol. 1, 1837, p. 367.

Steniolia PATTON, Bull. U. S. Geol. Surv., vol. 5, 1880, p. 364.

Steniolia HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 98, Abth. 1, 1889, p. 504.

Steniolia KOHL, Die Gatt. d. Spheg., 1896, p. 435.

Type.—*Bembex longirostra* Say (monobasic).

The wasps belonging to this genus vary in length from eighteen to twenty millimeters. The head when viewed from in front is wider than long, its width being about equal to that of the thorax. The compound eyes are large and strongly arched; their inner borders are approximately parallel and below they reach almost to the base of the mandibles. On the frons between the antennae there is a short but very evident carina. The ocelli are not developed and their cicatrices are sunk in pits; the posterior pair are circular, the anterior one is elliptical, sometimes approaching the circular form. The occiput is very narrow and the cheeks are but moderately developed.

The mandible, which ends in a single point, has its outer margin entire and its inner margin provided with a tooth near the apex. The maxillae are unusually long, extending when at rest to the third pair of coxae. The tongue, equal in length to the maxillae, is provided at the base with a pair of long thread-like paraglossae. The maxillary palpus is composed of three segments, the labial of one. The labrum is large, blunt, and but slightly emarginate at the apex. It is swollen at the base and appears somewhat pear-shaped. It shows a flat-

tened, median area near the base, on either side of which there is a slight, rounded prominence.

The clypeus is arched, wider than long, its apical border straight or slightly arcuate; it bears a slight median carina continuous with the carina between the antennæ. These are long and slender and possess few characters of value in separating species, although in the case of the male of some species several of the flagellar segments are carinate on the posterior surface. The antennae are inserted on the frons quite close to the basal margin of the clypeus and the distance between the points of insertion is slightly less than the distance from the point of insertion to the inner margin of the adjacent eye. They consist of 13 segments in the male and of 12 in the female.

The collar, or posterior border of the prothorax, is quite narrow and is placed much below the level of the scutum. The tubercles do not reach the tegulae above. The scutum, scutellum, and metanotum are relatively flat. The epimeron of the mesothorax is well defined, but the suture uniting the episternum and sternum of the mesothorax is lacking. The metapleura joins the side of the median segment almost at a right angle, thus forming a depression into which the femur of the middle leg is drawn when at rest.

The median segment is rather short and tapers toward the posterior. Its lateral angles are not compressed but are rounded off. As in related genera, the dorsal middle-field of the median segment is large, plainly set off, and is extended down upon the nearly vertical posterior surface of the segment. The tergites are arched, the sternites almost flat. On no species is there found a pygidial area set off by lateral lines on the ultimate tergite of the female. The second sternite of the male bears near its posterior margin a median, pointed, backwardly directed, tooth-like process that in most species is prominently developed, but in one is quite rudimentary. The sixth sternite is without a process of any kind in this genus and the seventh is concealed beneath the sixth. The eighth sternite of the male ends in three spines and a fourth is present upon the disk. The development of the spines affords specific characters. The genitalia of the male consists of a short basal piece, which bears the long lateral genital stipites, a pair of median curved sagittae, above which on the median line lies the spatha which ends in a pair of hooks.

The front wing. The pterostigma is vestigial. The radial cell, which is nearly as long as the first cubital cell, is narrowed toward its apical end, which lies on the costal border. Of the three cubital cells the first is long, exceeding the combined length of the second and third. The second is shorter than the third, rectangular in form though usually somewhat narrowed on the radial vein; it receives both discoidal cross veins. The third cubital cross vein is strongly bent toward the apical border of the wing but does not extend far-

ther toward the margin of the wing than the end of the radial cell. The angle formed by this vein and the radial vein and opening toward the apical border of the wing is acute. The second discoidal cross vein on its anterior third is strongly bent toward the apical border of the wing but is not angular and does not subtend a short vein. The first submedian cell, which terminates near the origin of the basal vein, is scarcely longer than the second, which gradually increases in breadth toward its distal end. The basal vein joins the subcosta at a distance from the radial cell equal at least to the length of that cell.

The hind wing. The retinaculum consists of a row of small hooklets beginning near the origin of the radial vein and extending toward the apex of the wing. The median cell is greatly prolonged, reaching almost to the apical border of the wing toward which two short veins extend from the end of the cell. The submedian cell ends anterior to or at the origin of the cubital vein. The hinder angle of the submedian cell, formed by the junction of the submedial and submedial cross veins, is obtuse.

The legs are relatively long and slender. The middle coxae are slightly separated from one another and the middle femora are never toothed, serrate, or dentate on species thus far discovered. The tibiae and tarsi are provided with more or less well-developed spines. The anterior tarsi of the female are provided with combs, consisting of long spines, of which seven are present on the metatarsus and two on each of the three following segments. These tarsal combs are weakly developed on the males and those males having the middle tibiae dilated lack the combs altogether. In the case of the males of the two species that have the middle tibiae dilated the middle metatarsus is somewhat curved and the distal half is flattened and thin. The claws are slender and the pulvilli are well developed.

The sculpturing is fine, close, and uniform, and affords little ground for the distinguishing of species. The pubescence is more prominent on some species than on others, is better developed on the male than on the female and is most conspicuous in all cases on the head, thorax, median segment, and base of abdomen. The maculations consist of spots, stripes, and lines on the head, thorax, and median segment, and of bands, continuous or broken, on the segments of the abdomen. The color of the maculations varies among the species from bright yellow to nearly clear white.

Steniolia is distinguished from nearly related genera as follows: from *all* by the unusual length of the proboscis; also from *Bicyrtes* by the form of the median segment, the number of segments in the palpi, the character of the ocellar cicatrices, the apical narrowing of the radial cell, and the form of the eighth sternite of the male; from *Stictia* by the number of segments in the palpi and the apical narrowing of the radial cell; from *Bembix* by the character of the ocellar

cicatrices, the number of segments in the palpi, the form of the eighth sternite of the male, the narrowing of the radial cell, the direction of the submedial cross vein of the hind wing, and the character of the outwardly opening angle formed by the third cubital cross vein and the radial vein; from *Microbembex* by the character of the ocellar cicatrices, the form of the eighth sternite of the male, and the fact that the apical end of the radial cell in the wing of *Microbembex* does not lie on the costal border.

KEY TO SPECIES.

Males.

1. Middle tibiae not dilated.....2.
1. Middle tibiae dilated.....5.
2. Apical segment of tarsi black.....*nigripes*.
2. Apical segment of tarsi not black.....3.
3. Abdomen almost entirely yellow.....*sulfurea*.
3. Abdomen black and yellow.....4.
4. Length, 14-18 mm.; dorsal abdominal maculations yellow; spot on mesopleura large, usually meeting its fellow on the midventral line.....*duplicata*.
4. Length, 18-20 mm.; dorsal abdominal maculations soiled white; spot on mesopleura small, never meeting its fellow on midventral line.....*albicantia*.
5. Abdominal maculations white.....*obliqua*.
5. Abdominal maculations yellow.....*tibialis*.

Females.

1. Middle tibiae not dilated.....*duplicata*.
1. Middle tibiae dilated.....2.
2. Abdominal maculations white.....*obliqua*.
2. Abdominal maculations yellow.....*tibialis*.

STENIOLIA NIGRIPES, new species.

Figs. 7, 12, 17, 18, 19.

Male.—Black: Labrum, mandibles except tips, clypeus, scape and first two flagellar segments below, lower part of frons continuous with the broad anterior orbits, which are narrowed above, triangular spot on either side of anterior ocellus, narrow posterior orbits broadened below, posterior border of pronotum and spot on sides of prothorax united on tubercles but separated in front of them by a long irregular black spot, spot on tegulae, short lateral line above tegulae and pair of discal spots on scutum, triangular spots on scutellum, metanotum, curved fascia on dorsum of median segment extended onto its posterior surface where there is a narrow medial interruption, lateral angles and sides of median segment, large irregular spot on mesopleurae, metapleurae, longitudinal line on mesosternum united at either end with the large spot on mesopleurae thus enclosing a large black area, broad fasciae on tergites 1-6, first interrupted medially, deeply emarginate anteriorly in the middle and acutely though less deeply emarginate posteriorly on either side of the median line,

second continuous though emarginate anteriorly in the middle, the emargination produced to right and left in the middle of the fascia, also thrice emarginate on posterior border, remaining fasciae of similar pattern with emarginations reduced on each succeeding segment, apex of ultimate tergite, first sternite except small lateral spots, second except small anterior lateral spots and a median longitudinal spot, broad fasciae on sternites 3-6 narrowed somewhat irregularly in the middle, coxae, trochanters more or less, femora except a stripe above on all pairs and a stripe below on first pair, tibiae, and tarsi except all apical segments, *yellow*.

The color on the abdomen is light greenish yellow, while that on the rest of the body is of a deeper shade. Segments 3-5 of the flagellum are reddish below, the apical segment slightly curved, and segments 5-11 on the posterior surface are slightly carinate. As on *duplicata* small pits occur on these carinae, but they are limited to the middle part, whereas on *duplicata* they extend the full length of the carina. The legs show no special structures, but the apical segment of all tarsi is black. The head, thorax, basal joints of legs, and base of abdomen are covered with moderately dense white pubescence, rather short except on the head, on the vertex of which it assumes a brownish shade. The spine on the second sternite is short, sharp, and directed obliquely backward. Of the three spines which terminate the eighth sternite the two lateral are quite short, and the middle one, long and very heavy, bears on its ventral side beyond its middle point distally a fourth very short spine.

Length.—18 millimeters.

Habitat.—Los Angeles, California.

Number of specimens—male 1, female, 0.

Type.—Male, in the collection of the American Entomological Society of Philadelphia.

STENIOLIA SULFURÆA Fox.

Steniolia sulfurea Fox, Journ. N. Y. Ent. Soc., vol. 9, 1901, p. 84.

Male.—Black: Clypeus, labrum, mandibles except tips, scape except black line above, spot between insertions of antennae, spot on each side of anterior ocellus, anterior orbits, posterior orbits shortened and narrowed above, small spot on tegulae, narrow line on posterior border of sides of prothorax, small spot on anterior part of mesopleurae low down and extending onto the mesosternum, on one specimen second small spot below insertion of wing, two small spots on metapleurae, legs except a variable amount of black on coxae and trochanters, and abdomen entirely except the basal part of the first segment, *bright sulphur yellow*.

The pubescence on the head, thorax, and base of abdomen is long, dense and white except on the vertex and the scutum where it is

somewhat dusky. The flagellum is yellow below basally but is darker toward the apex. Flagellar segments 3-8 on the posterior surface are slightly but distinctly carinate. On the distal border of the second sternite there is a rudimentary process. On one specimen the distal half of the apical tarsal segment is black; on the other there is only a suffused trace of this dark color. This species is very distinct and can not be confused with any other thus far described from the United States.

Length.—About 20 millimeters.

Habitat.—California.

Number of specimens—males, 2; females, none.

Type.—Male, in the collection of the American Museum of Natural History at New York.

STENIOLIA DUPLICATA Provancher.

Figs. 1, 8, 13, 20, 21, 22.

Steniolia duplicata PROVANCHER, Add. Faun. Canada, Hymen., 1888, p. 414, male and female.

Steniolia scolopacea HANDLIRSCH, Sitz. Acad. Wissensch. Wien, Math.-Nat. Cl. vol. 98. 1889, p. 510, male, female.

Steniolia duplicata Fox, Ent. News, vol. 2, 1891, p. 195.

Steniolia edwardsii PATTON, Proc. Ent. Soc. Wash., vol. 3, 1894, p. 45.

Steniolia scolopacea HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 104, Abth. 1, 1895, p. 965.

Male.—Black: Clypeus, mandibles except tips, labrum, scape, first two flagellar segments below, frons below insertion of antennae, broad anterior orbits narrowed above, triangular spot on either side of anterior ocellus sometimes united below it, narrow posterior orbits broadened below, posterior border of pronotum and large spot on side of prothorax united on tubercles but separated by a long irregular black line in front of them, spot on base of anterior wings, tegulae anteriorly, short line on scutum above base of wings, pair of discal spots and frequently a short transverse median line on posterior border of same, pair of triangular spots on scutellum, metanotum, curved fascia on dorsum of median segment extending onto the posterior surface where it is interrupted medially, lateral angles and sides of median segment, large spot on mesopleurae, small one above this beneath base of anterior wing, large spot on metapleurae, broad fasciae on all tergites usually interrupted medially and emarginated both anteriorly and posteriorly in such a fashion as to cut off more or less completely a pair of median rounded spots on the more anterior tergites, first sternite except anterior lateral spots, second except pair of anterior lateral and median longitudinal spots which in many specimens are united, fasciae on sternites 3-6 undulate anteriorly, coxae except basally, trochanters below, femora except stripe above, tibiae except stripe on posterior side of first pair, and tarsi, *yellow*.

The wings are hyaline and the veins brown. The body and the basal joints of the legs are covered with moderately dense white pubescence, longest on vertex, at base of mandibles and on posterior part of median segment. Pubescence of the abdomen except on base of first segment is much shorter than elsewhere on the body. The flagellum, except two basal joints, is reddish below darkening toward the apex and is slightly carinate posteriorly on segments 7-11, the carina inclosing small longitudinal pits. The second sternite bears a well developed process and the eighth ends in three curved spines of which the central, longer one has, arising from its base beneath, a fourth spine, short, stout, pointed and obliquely directed backward.

The female is quite similar to the male in general appearance and color markings. The lower surface of the flagellum is somewhat lighter and the yellow, especially on the scutum and the abdomen, is somewhat more extensive, consequently fewer of the fasciae on the tergites are interrupted medially and the median paired spots less frequently completely formed. The yellow on the sternites is also more extensive. In some specimens the black is limited to a medial spot on the second and narrow basal borders on sternites 3-5. The ultimate segment is yellow apically with a deep median anterior notch above and a less evident one below, and its tergite basally bears at the sides a cluster of short stout spines.

Length.—14-18 mm.

In the last volume of his monograph, page 965, Handlirsch places *duplicata* Provancher as a probable synonym of *scolopacea* Handlirsch, giving as his reasons for so doing the fact that the two descriptions were published at about the same time and that he could not determine from Provancher's description whether it was based upon *scolopacea* Handlirsch or *tibialis* Handlirsch. I cannot accept this contention. The description of *duplicata* Provancher, which appeared in the issue of *Le Naturaliste Canadien* for November, 1888, was published prior to that of *scolopacea* Handlirsch. Provancher's type is what is known to entomologists in America as *duplicata*; it is not *tibialis* Handlirsch. It, therefore, can not by any possible means be made a synonym of *scolopacea* Handlirsch and must stand as a good species. As far as it is possible to judge from the description of *scolopacea* given by Handlirsch his species is identical with Provancher's *duplicata*.

Habitat.—Mexico, New Mexico, Arizona, California, Colorado, Utah, and Washington.

Number of specimens, males 267, females 195.

STENIOLIA ALBICANTIA, new species.

Figs. 9, 14, 23, 24, 25.

Male.—Black: labrum, mandibles except apices, clypeus except a pair of small black basal spots, spot on either side of anterior ocellus, space between antennae, scape and first two flagellar segments below, anterior and posterior orbits, posterior border of pronotum, tubercles and more or less of the sides of the prothorax, spot on tegulae, small lateral spots on scutum above base of wing, triangular lateral spots on scutellum, fascia on metanotum, small spot on mesopleurae, spot on metopleurae, large spot on sides of median segment, smaller one near the spiracle of the segment, fascia of first tergite broken into pair of large lateral spots and a pair of dorsal triangular spots on posterior part of tergite, fascia of second similar to that of first, but with the anterior border of the lateral spots prolonged medially and the pair of dorsal spots larger and more elliptical, remaining fasciae similar in design but in most specimens not broken into dorsal and lateral spots, apex of ultimate tergite, continuous fasciae on all sternites emarginate medially, spot on coxae below, stripe on anterior and posterior surfaces of femora, tibiae except spot below on all, and tarsi, *pale yellowish or soiled white*.

Length.—18–21 mm.

In development the antennae, legs, and genital stipes are quite similar to those of *duplicata*. Segments 4–11 of the flagellum bear narrow elongate pits on the posterior surface. The second sternite bear a prominent, pointed spine. It differs from *duplicata* in having the pubescence of the head and thorax somewhat better developed, in being of larger size, in having the mesosternum black, and in the reduction of the markings of the scutum and dorsum of the median segment, which latter is without maculations on the type and on all specimens except one. It is more robust than *duplicata*, showing a relatively greater width of thorax and abdomen. Furthermore, the maculations, especially the dorsal markings of the abdomen, are in color quite distinct from those of *duplicata*. In that species the markings are usually a bright clear yellow, whereas in *albicansia* they are a soiled faded yellow or muddy white.

Habitat.—Washington and Oregon.

Number of specimens examined—males 9, females 0.

Type.—Cat. No. 19802 U.S.N.M.**STENIOLIA OBLIQUA** Cresson.

Figs. 10, 15, 26, 27, 28, 31.

Monedula obliqua CRESSON, Proc. Ent. Soc. Phila., vol. 4, 1865, p. 469, female.*Steniolia obliqua* HANDLIRSCH, Sitz. Akad. Wissensch. Wien, vol. 98, 1889, p. 511, pl. 1, fig. 16, female and male.

Male.—Black: Clypeus, labrum, mandibles except tips, scape and first two segments of flagellum below, frons below insertion of anten-

nae, broad anterior orbits narrowed above, very narrow interrupted posterior orbits, spot on anterior and medial coxae below, sometimes spot on mesosternum just behind anterior coxae, anterior femora anteriorly for the most part, medial and posterior femora on anterior surface distally, tibiae except stripe on posterior surface, *pale greenish yellow*. Spot on tubercles, spot on tegulae, pair of triangular spots laterally on scutellum, short fascia on metanotum, fascia of first tergite broken into a pair of median rounded spots and a pair of large lateral spots, fasciae on tergites 2-6 continuous and undulate, that on second extended forward on either side of the midline in the form of an inwardly directed tooth, ultimate tergite apically, lateral spots on sternites 2-6, and tarsi more or less, *white*.

The apical segment of the posterior tarsus is black and the remaining segments distally more or less so; the distal half of the ultimate segment of the middle tarsus is also black. The head, thorax, basal joints of the legs including the femora, first segment of the abdomen above and first and second below are densely covered with a long white pubescence. On the posterior part of the abdomen the pubescence is shorter and less conspicuous. The flagellum at the union of the segments is distinctly notched posteriorly and most evident at the distal end of segments 5-9. The somewhat prominent areas seen on segments 6-11 posteriorly lack the pits found on *duplicata*. The middle femora are dilated apically and the spine at the distal end in front is strongly curved. Seen from in front the basal half of the middle metatarsus appears curved or emarginate on the inner side and the distal half dilated, due to the presence of a broad but thin carina on the inner surface running somewhat obliquely downward and forward to the tip of the joint. The second sternite bears a distinct tooth-like process and the eighth ends in three short very hirsute spines. At the base of the middle one on the ventral surface there is a short blunt process from which two carinae diverge basally. The dorsal aspect of this ventral plate is characterized by a semicircular crest continuous with the base of the outer spines and enclosing a prominent pit at the base of the middle spine.

Female.—Black: Clypeus, labrum, mandibles except tips, scape and first two flagellar segments below, frons below insertion of antennae, broad anterior orbits narrowed above, narrow interrupted posterior orbits, posterior margin of pronotum united with tubercles from which a line extends downward, spot on tegulae, spot on anterior and middle coxae below, anterior and posterior stripe more or less well developed on anterior and middle femora, posterior femora distally, tibiae except spot on posterior surface, and coxae, *yellow*, the color deeper on legs than elsewhere. Triangular lateral spots on scutellum, fascia on metanotum, fascia on first tergite broken into a pair of rounded medial spots and broad lateral spots, undulate continuous

fasciae on tergites 2-5, that on segment two on either side of midline prolonged forward in the form of an inwardly pointed tooth, those on third and fourth less prolonged, ultimate tergite with bilobed spot at apex, lateral spots on sternites 2-6, *white*, sometimes tinged with greenish yellow.

The distal joint of the flagellum is reddish at the apex and the segments beyond the second are more or less so below. The middle tibiae are dilated; the first segment of the middle tarsus is only slightly curved basally and lacks the carina found on the male. The pubescence is similar to that of the male but somewhat less well developed.

Length.—14-16 mm.

The color of the markings of this species varies from yellow through yellowish or greenish white to almost white. All the flagellar segments may be lighter beneath than above, but the light color is more pronounced on the proximal ones and always more in evidence on the female than on the male. The lateral spots on sternites 2-5 may or may not be connected by apical lines on the female; they are not so connected on the male. The spots on the sixth sternite of the female are sometimes united. On some specimens there is an irregular spot on the side of the median segment posteriorly, extending slightly onto its posterior surface. The line on the posterior border of the pronotum of the male may be wanting or present as two widely separated spots, and the fasciae on tergites 2-4 may be interrupted medially.

In this species the eyes are not so widely separated as in *duplicata*, and in both males and females they are distinctly divergent at the clypeus.

Habitat.—Colorado, Utah, Wyoming, British Columbia.

Number of specimens examined—males 8, females 14.

STENIOLIA TIBIALIS Handlirsch.

Figs. 11, 16, 29, 30, 32, 33.

Steniolia tibialis HANDLIRSCH, Sitz. Akad. Wissensch. Wien, vol. 98, 1889, p. 513, pl. 2, fig. 1, male and female.

Male.—Black: Labrum, mandibles except tips, clypeus, scape below, first two flagellar segments below, small spot between antennae, anterior orbits, narrow posterior orbits, broken line on posterior border of pronotum, tubercles and narrow line on sides of prothorax, spot on tegulae, lateral spots on scutellum, sometimes short fascia on metanotum, pair of large lateral spots and pair of small medium posterior dorsal spots on first tergite, continuous fasciae on tergites 2-6, that on second with a deep anterior medial emargination which is produced to right and left posteriorly, remaining fasciae with shallow anterior median biemarginations, seventh tergite apically, lateral spots on sternites 2-6, femora distally more or less, tibiae except line on first pair below, and tarsi, *yellow*.

The flagellum, except the basal segments below, is black and although specialized areas are present these do not bear pits as do those found on *duplicata*. The middle tibia and metatarsus are modified in a fashion almost identical with that of *obliqua*. The apical half of the ultimate segment of the tarsi is decidedly dusky. The process on the second sternite is short sharp and obliquely directed backward.

Female.—Black: Clypeus, labrum, mandibles except tips, scape, and basal joints of flagellum below, frons below insertion of antennae, small spot before anterior ocellus, anterior orbits, posterior orbits quite narrow above, posterior of pronotum, tubercles, spot on tegulae, brief lateral line on scutum above base of anterior wings, large lateral spots on scutellum, fascia on metanotum, spot on lateral angles of median segment extended on the side and somewhat on the posterior surface of same, spot on mesopleurae, small spots on metapleurae, fascia of first tergite broken into a pair of very large lateral spots and a pair of elliptical medial spots approximated on median line, the remaining fasciae slightly undulate laterally, deeply and double emarginate medially, the fasciae on second and third produced forward and inward on either side of the emargination, most conspicuous on second, broad fasciae on sternites 2-5, ultimate segment apically both above and below, spot on coxae below, quite small on posterior pair, anterior and posterior borders of anterior and middle femora, most evident on anterior pair, and coxae, *yellow*.

The intermediate tibiae are dilated as in the case of *obliqua* and the first segment of the middle tarsus is slightly curved basally; wings very slightly infumated. The pubescence is similar to that of *obliqua*, to which species this one is very similar, save in the color of the maculations.

Length.—16 mm.

Habitat.—California, Nevada.

Number of specimens—males 3, females 3.

Genus STICTIA Illiger.

Vespa signata LINNAEUS, Systema Naturae, ed. 10, vol. 1, 1758, p. 574.

Bembyz FABRICIUS, Syst. Ent., 1775, p. 361.

Bembex FABRICIUS, Mant. Ins., vol. 1, 1787, p. 285.

Monedula LATREILLE, Hist. Nat. Ins., vol. 3, 1802, p. 343.

Stictia ILLIGER, Fauna Etrusca (Rossi), ed. 2, vol. 2, 1807, p. 131.

Bembex DAHLBOM, Hym. Eur., vol. 1, 1845, p. 486.

Monedula DAHLBOM, Hym. Eur., vol. 1, 1845, p. 492.

Monedula BURMEISTER, Bol. Acad. Cordova, vol. 1, 1874, p. 110.

Monedula HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 99, Abth. 1, 1890, p. 77.

Monedula KOHL, Die Gatt. d. Spheg., 1896, p. 436.

Stictia FOX, Ent. News, 1901, p. 269.

Type.—*Vespa signata* Linnaeus, by present designation.

The head seen from in front is broader than long and almost as broad as the thorax. The compound eyes are large and strongly arched. The inner margins are divergent at the clypeus, rarely sub-parallel, and the lower margin reaches the base of the mandible. The facets near the inner border of the eye are slightly larger than those near the outer border, the change in size from one margin to the other being almost imperceptible. The frons on the males is usually narrower than the compound eye measured at the level just above the insertion of the antennae; on the females it equals or exceeds the width of the eye at the same level. The ocellar cicatrices are flat, not sunk in a pit, and are semicircular in form. The anterior one is greater than a semicircle, somewhat horseshoe-shaped, with the opening directed toward the clypeus; the posterior ones are a trifle greater than a semicircle, of which the open side is toward the compound eye. The precipitous posterior surface of the head is concave and the temples are quite narrow.

The outer border of the mandible is entire, the apex simple, and the inner border provided with three teeth. The labrum is relatively flat, longer than broad, and, as in the case of *Bicyrtes*, is bluntly rounded at the end, not emarginate. The maxillae are moderately long, stoutly developed and each is half-conical in form so that when the two are approximated they form a tube within which lies the tongue. The maxillary palpi consist of six segments, the labial of four. As in the case of *Bembix* the maxillae when folded at rest are concealed beneath the labrum. The clypeus is wider than long and is but slightly arched, less so than in the case of *Bembix*. On the distal median part above the base of the labrum there is in nearly all species a somewhat triangular area above which on the median line there is a short but evident carina continuous with the median carina of the frons separating the antennae. On either side of this carina the base of the clypeus slopes abruptly in toward the insertion of the antenna. The antennae are inserted quite close to the base of the clypeus and consist in the female of 12 segments, in the male of 13, in which case several of the flagellar segments may bear modifications that are useful in determining species.

As in the case of *Bembix* the dorsum of the thorax is relatively flat, the posterior border of the prothorax is much below the level of the scutum, and the tubercles do not reach the tegulae. The suture between the sternum and episternum of the mesothorax is obliterated. The median segment shows a clearly defined, broad, dorsal middle-field, which is continued upon the almost vertical posterior surface of the segment. The lateral angles of the segment are roundly prominent, not so sharply compressed as in the case of *Bicyrtes* nor so bluntly rounded off as in the case of *Bembix*.

The abdomen is relatively stout and widest at the junction of the first and second segments. The tergites are strongly arched, the sternites flat. The ultimate tergite of the males is provided with prominent lateral processes or spines and the median prolongation is emarginate at the end. The ultimate tergite of the females lacks the spines, is rounded apically, and its surface, punctate or slightly rugose, is without a pygidial area. On the second sternite of the male there is a median prominence or carina more or less well developed; this is also discernible on the females of some species, but on others it is wholly lacking. The sixth sternite of the male bears a conspicuous median area that is slightly raised and is finely punctate or granular. The eighth sternite of the male ends in a single, stout, curved spine.

The male genital armature consists of a basal piece (cardo) which bears the lateral stipites, the median spatha, and below this the sagittae. The stipites are strongly chitinized, long, curved, and pointed. The spatha is roundly dilated at the end and bears a deep median cleft. The form is distinctly different from that in any of the closely related genera. The sagitta is a divided structure; the dorsal or inner part, the longer and the more slender of the two, is weakly chitinized and somewhat hirsute; the ventral or outer part is heavier, shorter, not strongly chitinized and very hirsute.

The legs are relatively long and strong. The middle coxae are separated. The middle femora of the males bear near the distal end on the lower border a conspicuous, curved, distally directed tooth. All tibiae and tarsi in both sexes are beset with spines, which are better developed in the female than in the male. In both sexes the anterior tarsi are provided with tarsal combs, which are much better developed in the females than in the males. The pulvilli are large and conspicuous and the middle tibiae bear at the distal end a single spur.

The wings are much like those of *Bembix*. The pterostigma of the anterior wing is obliterated. The radial cell is long, narrow, of nearly uniform width and rounded at the distal end, which lies on the costal border of the wing. The first cubital cross vein, as in *Bembix* near its posterior end is strongly bent toward the proximal end of the wing. The second cubital cell, which receives both discoidal cross veins, is much wider on the cubital vein than on the radial. The third cubital cross vein is deflected toward the distal end of the wing and at the posterior end is rounded so that the third cubital cell extends as far toward the distal end of the wing as does the radial cell. The angle formed by the junction of the radial and third cubital cross veins and opening outward is acute. The first submedian cell is longer than the second, which steadily increases in width

toward the distal end. The basal vein arises at the distal end of the first submedian cell.

The retinaculum on the hind wing, consisting of an unbroken row of hooklets, begins proximal to the origin of the radial vein, which reaches near to the distal end of the wing. The median cell is long. The cubitus arises quite near the distal end of the submedian cell. The posterior distal angle of the submedian cell formed by the submedian and submedian cross veins is obtuse, sometimes approaching a right angle. The submedian vein terminates in the anal sinus. In some species the wings are more or less infumated, in others they are hyaline.

The pubescence is short and inconspicuous, especially on the females. The punctation is shallow, fine, and uniform affording little ground for the separation of species.

This generic description is based on a limited number of species from the United States, Mexico, West Indies, Central and South America

KEY TO SPECIES.

Males.

1. Lateral spines of seventh tergite pointed at tip; thorax maculated; first tergite with a double fascia interrupted medially; fasciae of following tergites not broken into spots.....*signata*.
1. Lateral spines of seventh tergite truncate at tip; thorax immaculate; fascia on third tergite reduced to four (rarely two) spots.....*carolina*.

Females.

1. Scutum with a pair of lateral and pair of discal stripes; sternites 1-4 almost wholly yellow.....*signata*
1. Scutum black; yellow on sternites confined to triangular lateral spots.....*carolina*.

STICTIA SIGNATA Linnaeus.

Figs. 34, 35, 38, 39, 43.

Vespa signata LINNÆUS, Syst. Nat., ed. 10, vol. 1, 1758, p. 574.

Bembex signata FABRICIUS, Syst. Ent., 1775, p. 361.

Bembex vespiformis OLIVIER, Encycl. Meth., vol. 4, 1789, p. 290, pl. 106, fig. 18.

Monedula signata LEPELETIER, Hym., vol. 3, 1845, p. 283.

Monedula signata HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 99, 1890, p. 86.

Male.—Black: Labrum, mandibles except apices, clypeus except a pair of vertical lines basally which may be broken into spots, lower part of frons usually extended medially above the insertion of the antennæ, scape below, broad anterior orbits ending above in a lateral spot on either side of the anterior ocellus, posterior orbits broad below, narrow above, and ending in a small spot on either side of the vertex, posterior border of pronotum continued to the tubercles, where it is united with a large spot on sides of prothorax, pair of

broad lateral lines and pair of discal lines on scutum, spot on tegulae, spot on base of anterior wings, fascia on anterior margin of scutellum widest laterally, metanotum, curved fascia on dorsum of median segment, pair of triangular spots on its posterior surface, which are sometimes united with the fascia above, its postero-lateral angles and its sides almost wholly, mesopleuræ and metapleuræ except borders of sutures, mesosternum except pair of lateral spots, fasciae of tergites, interrupted medially, the first broad laterally and horseshoe-shaped dorsally on either side of the midline, second to fifth of the same pattern as the first, but with the anterior half of the horseshoe more or less imperfectly developed, sixth broken into four spots, pair of lateral spots on ultimate tergite, sternites 1-5 except medial spots on 2-5, which on 5 and sometimes on 4 are continuous with an anterior black border, the legs except small black spot on posterior side of all femora and black spot on knees prolonged on upper side of posterior tibiae, *yellow*.

The flagellum is black, with the underside somewhat testaceous especially toward the apex. Its ultimate segment is slightly curved and obliquely truncate apically. Segments 6 and 10-12 are excavated or pitted and 7-9 are somewhat rounded out below. The middle femora below near the distal end bear a short, blunt, curved tooth. The second sternite basally bears a moderately developed carina. The sixth is black and medially bears a slightly raised, transverse, semicircular area conspicuous for its fine, close punctation. The ultimate tergite is notched at the tip and its lateral angles are developed in the form of short, stout, acutely pointed spines.

Female.—The female is quite similar to the male in general appearance, but to the color description of the male the following additions are necessary: The triangular spots on the posterior surface of the median segment are usually united with the fascia above them; the anterior branches of the horseshoe on the first tergite are extended downward on the anterior surface of the segment; there is a black stripe above on all femora and also on all tibiae; there is a line below on middle femora and also on middle and anterior tibiae; and the black spots on the mesosternum are quite small. The ultimate sternite is black and faintly carinate medially; the ultimate tergite bears a pair of lateral yellow spots and is closely and regularly punctured, showing a slightly rugose appearance and a fairly well-marked longitudinal median ridge.

In both sexes the discal marks on the scutum are more or less rufous, and the legs are a deeper yellow than the markings of the body. The wings are hyaline and the veins brownish black. The pubescence is short, rather sparse and inconspicuous except on the vertex and on under parts of the thorax. There is but little variation in the markings.

Length.—22–24 mm.

This is one of the commonest of tropical species and has been reported from Mexico, West Indies, and as far south as the Argentine Republic. Fox in his Synopsis of the Bembicini of Boreal North America reports a single specimen from California, taken by D. W. Coquillett. I have before me from Mexico and the West Indies 9 males and 13 females.

STICTIA CAROLINA Fabricius.

Figs. 2, 36, 37, 40, 41, 42, 44.

Bembex carolina FABRICIUS, Ent. Syst., vol. 2, 1793, p. 249.

Monedula carolina LATREILLE, Hist. Nat., vol. 13, 1805, p. 302, pl. 102, fig. 3.

Monedula carolina LEPELETIER, Hist. Nat. Hym., vol. 3, 1845, p. 281.

Monedula carolina HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 99, 1890, p. 110.

Male.—Black: Lateral stripes on labrum, pair of lateral spots and median stripe on clypeus usually contiguous, spots between antennae, base of mandibles, scape below, anterior and narrow posterior orbits both shortened above, *white or greenish yellow*. Fasciae of first tergite broad laterally, acutely narrowed, and rather widely interrupted medially; second, broad laterally, somewhat less widely interrupted medially, roundly emarginate on either side of the midline with anterior margin curved forward medially; third usually broken into four spots, sometimes only two; small lateral spots occasionally on tergites four and five, lateral spots on seventh usually connected on midline, lateral spots on sternites 2–3 and occasionally on 4, tarsi above more or less, *light creamy or faintly greenish yellow*. Tibiae except a broad stripe on inner surface of posterior pair, distal extremities of femora, *orange-yellow*.

When seen from above the ultimate segment of the flagellum is roundly pointed at the apex, and segments 6–11 on their posterior surfaces show more or less well-marked prominences. Segments 6–12 bear pits on their posterior surfaces most conspicuous on segment 6. There is a conspicuous tooth on the underside of the apical end of the middle femora, which, when the legs are folded, is covered by a dilation on the posterior side of the base of the metatarsus. There is a trace of a median carina on the second sternite, and on tergite 6 there is a small, weakly developed median tubercle, behind which there is a transverse area more finely sculptured than the surrounding surface. The ultimate tergite is notched at the tip and each lateral angle is produced into a broad truncated spine.

Female.—Black: Labrum, mandibles except tips, clypeus except usually a pair of black spots basally variable in size, pair of spots continuous with the apical border of frons, scape below; anterior and narrow posterior orbits; broken line on posterior border of pronotum;

tubercles, spot on mesopleura posterior to tubercles, pair of small lateral spots on scutellum, sometimes wanting; spot on lateral angles of median segment, fascia on first tergite broad, interrupted and deeply emarginate medially, second interrupted medially and emarginate on either side of the midline anteriorly, third broken into four spots, fourth and fifth reduced to lateral spots; lateral spots on sternites 2-4, sometimes 2-5, femora distally; tibiae except more or less of posterior surfaces, tarsi, *yellow or pale greenish yellow*.

Length.—24-28 mm.

This handsome insect is our largest representative of the *Bembicini*. The variation in the markings is not wide but is more prevalent in the male than in the female. The distribution of the light and dark areas on the labrum and clypeus of the male differs with almost every individual, the prevailing pattern being set forth in the description above. The shade of the color of the markings is quite varied on the male, less so on the female. The wings are slightly infumated. The coxae, trochanters, and femora, except more or less of the apical ends, are black; the tibiae and tarsi are yellow, with more or less black below; the apical segment of the tarsi is somewhat dilated and in the male is mostly black. The pubescence is nowhere conspicuous except on the vertex, and the sculpturing on the body is fine and close. The labium in both sexes is covered with coarse, shallow, scattered punctures, and the apical portion of the ultimate tergite of the male is quite similarly punctured. The ultimate tergite of the female is densely and rather coarsely punctured and the apical portion appears somewhat rugose.

Habitat.—Pennsylvania, New Jersey, Georgia, Louisiana, Texas, New Mexico, Oklahoma, Kansas, and Illinois.

Number of specimens examined—males, 26; females, 19.

STICTIELLA, new genus.

Monedula HANDLIRSCH and Authors (part).

Type of the genus.—*Monedula formosa* Cresson.

The species belonging to this genus are on the whole more slender than those of the genera *Stictia* and *Bembix*, resembling more closely those of the genus *Steniolia*. In length they vary from 10 to 20 millimeters. The head when viewed from in front is broader than long. In the majority of species it is about as broad as the thorax; in a few, however, it is distinctly narrower than the thorax. The compound eyes are large, strongly arched and naked. The facets near the inner border are very slightly larger than those on the outer. The inner margins of the eyes are usually subparallel, occasionally divergent at the vertex. The lower margin reaches the base of the mandible. The precipitous posterior surface of the head is concave and the

temples are narrow. The ocellar cicatrices are circular or nearly so and are sunk in pits, the anterior one having a conspicuous elevation round about it.

The outer border of the mandible is entire, the inner is provided with one or two teeth and the apex is simple. The labrum is longer than broad at the base, not strongly arched, roundly truncate at the apex, but not emarginate. The maxillae are well developed, relatively as long as in the genus *Stictia*, half conical in shape and forming a tube enclosing the tongue which is strongly divided at the apex. The maxillary palpi are composed of six segments and the labial of four. The clypeus is much broader than long, and very slightly arched. There is no proximal median carina and no distal flattened median area. The distal border is curved. The antennae are inserted on the frons quite close to the clypeus and their insertions divide the distance between the compound eyes into three equal parts. In the male the antenna consists of thirteen segments, in the female of twelve. The flagellum of the male seldom shows conspicuous secondary sexual modifications, and consequently is of little use in the separation of species.

The dorsum of the thorax is relatively flat, but the posterior border of the prothorax is much below the level of the scutum, and the tubercles do not reach the tegulae. The suture between the sternum and the episternum of the mesothorax is obliterated. The median segment is short, its lateral angles are rounded, and its posterior surface nearly vertical and flat. The dorsal middle-field is clearly defined and is broadly continued on the posterior surface.

The wings are usually clear, rarely somewhat infumated. The radial cell at its distal end is narrowed and rounded and lies on the costal border of the wing. The first cubital cell in length exceeds the second and third combined. The first cubital cross vein is usually straight, in some species slightly bent near its junction with the cubitus but never so strongly as in the case of *Stictia* or *Bembix*. In many species the second cubital cell is about as wide on the radial as it is on the cubitus, but in others this cell is decidedly narrowed on the radial. It receives both discoidal cross veins. The third cubital cross vein is strongly bent outward, but its form and consequently the form of the third cubital cell vary somewhat in the different species. This cell extends as far toward the distal end of the wing as the distal end of the radial cell, and the angle formed by the radial and third cubital cross veins and opening outward is acute. The first submedian cell is longer than the second, which increases in breadth toward its distal end. The basal vein arises a short distance proximal to the distal end of the submedian cell.

On the hind wing the retinaculum, consisting of an unbroken row of hooklets, begins a short distance proximal to the origin of the

radial vein, which extends almost to the apical border of the wing. The median cell is long and distally bears two longitudinal veins (prolongations of the cubitus and radial) extending to near the border of the wing. The cubital vein arises at some distance from the submedian cell. The posterior angle of this cell, formed by the junction of the submedian and submedian cross veins is obtuse. The legs are relatively long and slender and, as in related genera, the middle coxae are not contiguous. In the female the combs of the anterior tarsi are strongly developed; in the males they are weakly developed or lacking. In the case of the male of many species the middle femora are serrate, dentate or emarginate. Likewise the middle metatarsus may be curved, in which case the inner curved surface may or may not bear a number of spines. In many species the tarsal segments especially the ultimate segments are more or less dilated and flattened. The tarsal claws are long, slender, and simple, but in one species those of the first pair of legs are modified and are not symmetrical. In many species the pulvilli are large and conspicuous; in others, much reduced or lacking. In one species the hind femora are emarginate.

The male genital armature consists of a basal piece (cardo), which bears the lateral stipites, the median spatha below which lie the sagittae. The stipites are large, more or less strongly chitinated, variable in form but never similar in general outline to those of *Stictia*. The median spatha is deeply cleft at the distal end, the two parts strongly chitinated, rounded and curved downward. At some distance from the distal end of the spatha on either side there is a short projection, like the barb of an arrow, somewhat similar to that found in the case of *Bembix*. As in related genera the sagitta is divided near its base into two parts. The inner division is strongly chitinated, rounded, curved and usually ends in a sort of hook. In the exerted genitalia the inner divisions of the two sagittae lie side by side directly below the spatha. The outer division of the sagitta is the shorter of the two, less strongly chitinated and usually somewhat hirsute.

KEY TO SPECIES.

Males.

1. Medial metatarsus more or less strongly curved; inner curved surface frequently beset with several spines 2.
1. Medial metatarsus not curved 12.
2. Second sternite nontuberculate 3.
2. Second sternite unituberculate 7.
2. Second sternite bituberculate 8.
3. Medial femora smooth beneath *pictifrons*.
3. Medial femora serrate or dentate beneath 4.
4. Pulvilli large and distinct; apical segment of all tarsi black; those of the anterior pair dilated and flattened *formosa*.
4. Pulvilli indistinct; tarsi normal 5.

5. Scutum with discal marks; abdominal fasciae all continuous.....*melanosterna*.
5. Scutum without discal marks; no continuous fasciae on venter of abdomen.....6.
6. Wings distinctly infumated; lateral ventral spots on abdomen not confined to sternites 2 and 3.....*serrata*.
6. Wings hyaline; lateral ventral spots on abdomen lacking or confined to sternites 2 and 3.....*plana*.
7. Apical segment of fore tarsus broadly dilated and black; process on second sternite blunt and strongly hirsute distally.....*tuberculata*.
7. Apical segment of fore tarsus normal and yellow; process on second sternite pointed and smooth distally.....*callista*.
8. Medial femora smooth; head narrower than thorax.....9.
8. Medial femora dentate or serrate below; head normal.....10.
9. Width of the second cubital cell on the radial vein and on the cubital about equal; second sternite almost wholly yellow.....*bituberculata*.
9. Width of the second cubital cell on the radial vein about half its width on the cubital; second sternite mostly black.....*emarginata*.
10. Pulvilli indistinct; apical segment of tarsi normal.....*pulchella*.
10. Pulvilli distinct; apical segment of tarsi black; anterior pair dilated.....11.
11. Large and stout, 18-20 mm; fasciae on tergites broad and except first continuous; second inclosing pair of black medial spots; fasciae on sternites 1-5 continuous or narrowly interrupted.....*spiciosa*.
11. Slender, about 15 mm; fasciae on tergites interrupted on 1 or on 1-3, leaving on one or more of these tergites a pair of yellow medial spots; yellow on sternites in the form of lateral spots.....*melampous*.
12. Head, thorax, base of abdomen and basal joints of legs covered with long, white, dense pubescence; most specimens but not all have the second sternite bituberculate.....*villosa*.
12. Pubescence of head, thorax, etc. of normal character.....13.
13. Second sternite nontuberculate.....*tenuicornis*.
13. Second sternite unituberculate.....*megacera*.
13. Second sternite bituberculate.....14.
14. Medial femora of normal form, not emarginate.....15.
14. Medial femora more or less strongly emarginate posteriorly.....16.
15. Scutum with a pair of large discal marks.....*exigua*.
15. Scutum without discal marks.....*pulla*.
16. Scape black above; mesosternum marked with black; genital stipes as in fig. 77.....*femorata*.
16. Scape entirely yellow; mesosternum yellow; genital stipes as in fig. 79.....*divergens*.

Females.

1. Pulvilli distinct.....2.
1. Pulvilli indistinct.....13.
2. Scutum without discal markings.....3.
2. Scutum with discal marks more or less well developed.....5.
3. Head narrower than thorax; width of second cubital cell on the radial vein about half its width on the cubital vein.....*emarginata*.
3. Head normal, wide as thorax; second cubital cell normal.....4.
4. Spots on scutellum rectangular; spots on either side anterior ocellus.....*pulla*.
4. Spots on scutellum triangular; V-shaped spot inclosing anterior ocellus.....*megacera*.
5. Discal marks consisting of a pair of irregular spots, or of lines not broken, not curved inward or approximated posteriorly.....6.
5. Discal marks in form of a U, either unbroken, interrupted medially, or broken into lines and spots.....7.
6. Scutellum with pair of large rectangular lateral spots.....*pulla*.

6. Scutellum with a continuous fascia, rarely narrowly interrupted on the median line.....*pictifrons*.
7. Second sternite more or less black; its lateral yellow spots sometimes connected apically.....8.
7. Second sternite wholly yellow.....10.
8. Species small, 10–12 mm.; discal marks narrow and broken; fasciae on tergites rather narrow, wavy, scarcely to be considered emarginate.....*femorata*.
8. Species larger, 16–20 mm.; discal marks two broad lines curved and approximated posteriorly; fasciae on tergites broad and emarginated anteriorly.....9.
9. Tergites without posterior black border; posterior tarsi save basal joint dusky above.....*speciosa*.
9. Tergites with a posterior black border; posterior tarsi yellow.....*formosa*.
10. Species large, 16–20 mm.....11.
10. Species small, 10 mm.....12.
11. Scape yellow; black spot on mesosternum near middle coxae.....*tenuicornis*.
11. Scape with black spot above; mesosternum yellow.....*bituberculata*.
12. Fascia of first tergite inclosing a medial black spot basally; head, thorax and base of abdomen sparsely covered with long white pubescence, most evident on lateral angles of median segment.....*scitula*.
12. Fascia of first tergite without medial black spot; not pubescent as above; face and sides of thorax more or less silvery.....*exigua*.
13. Scutum without discal markings.....14.
13. Scutum with discal markings.....15.
14. Mesopleura immaculate; fascia of first tergite interrupted widely.....*serrata*.
14. Mesopleura with large yellow spot; fasciae on tergites all continuous....*pulchella*.
15. Discal marks on scutum small; mesopleura black, rarely with small maculations; venter of abdomen almost entirely black.....16.
15. Discal marks on scutum conspicuous; mesopleura yellow; venter of abdomen almost entirely yellow.....17.
16. Wings infumated; fascia of first tergite widely interrupted and yellow....*serrata*.
16. Wings hyaline; fascia on first tergite narrowly interrupted and white.....*plana*.
17. Species large, 18–20 mm.; no black on mesosternum.....*callista*.
17. Species smaller, 12–14 mm.; black spot, variable in size, in front and slightly above the middle coxa.....*melanosterna*.

STICTIELLA PICTIFRONS Smith.

Figs. 45, 46, 80, 96.

Monedula pictifrons SMITH, Cat. Hym. Brit. Mus., vol. 4, 1856, p. 335, female.*Monedula inermis* HANDLIRSCH, Sitz. Acad. Wissensch. Wien, Math.-Nat. Cl., vol. 99, 1890, p. 144, male.*Monedula denverensis*¹ CAMERON, Trans. Amer. Ent. Soc., vol. 34, 1908, p. 235, female.

Male.—Black: Labrum, clypeus, mandibles except apices, scape, basal segments of flagellum below, lower part of frons extended upward between antennae, semicircular spot before anterior ocellus, sometimes connected with the yellow of the frons below, broad anterior orbits, posterior orbits broad below, posterior border of pronotum connected on tubercles with large spot on sides of prothorax, spot

¹ Mr. Rowland E. Turner has written Mr. Rohwer as follows: "I had placed the types of *denverensis* Cam. and *pictifrons* Sm. together. They are certainly the same species although the carina of the anterior ocellus is more clearly defined in *denverensis* giving the depression a deeper appearance. The shape of the second cubital cell is the same."

on tegulae, short lateral lines above tegulae on scutum, lateral spots on scutellum narrowed and approximated medially, fascia on metanotum, curved fascia on median segment above, narrow laterally and broad on posterior surface, where it may be interrupted medially, lateral angles of median segment, sides of same almost entirely, large spots on metapleurae, large spot covering almost the entire mesopleurae and continuous with the yellow on mesosternum inclosing a black spot in front of middle coxae, fascia on first tergite broad laterally, widely and deeply emarginate on anterior middle, the emargination usually extended back from its lateral angles to meet the posterior black border thus inclosing a median bilobed yellow spot, the remaining fasciae of similar pattern, second about as broad as first, others narrower, medial emargination shallower and not extended backward to meet the posterior black border of the segment, sixth fascia sometimes broken into three spots, apex of ultimate tergite, first sternite except lateral basal spots, second except basal border, broad fasciae on third and fourth and narrower ones on fifth and sixth on some specimens, on others large connected lateral spots on third and fourth and disconnected lateral spots on fifth and sixth, coxae, trochanters except spot above, femora except stripe above, tibiae except sometimes a minute stripe on posterior pair above, tarsi except more or less above, *pale yellow* or *yellowish white*.

The yellow is brightest on the legs, sides of thorax, and the under sides of the abdomen. The under surface of the flagellum gradually changes from yellow to testaceous toward the apex, where the ultimate segment is slightly flattened and curved. The anterior tarsi are conspicuously flattened and bear a moderately well-developed tarsal comb, and segments three and four bear well-developed posterior apical processes that are invariably black and are characteristic of this species. The middle and posterior tarsi are less evidently flattened, but segments 3 and 4, and 5 basally, are black above. A male from Arizona shows the black marks only on the anterior tarsi. The middle femora are smooth and the middle metatarsus is curved, but is without spines on curved surface. The second sternite is without process of any kind and the eighth bears a discal spine.

Female.—Black: Labrum, clypeus, mandibles except apices, scape, flagellum basally below, frons below, large spot inclosing anterior ocellus frequently united with yellow on lower part of frons, broad anterior orbits, posterior orbits broad below and frequently continued across the posterior border of vertex, posterior border of pronotum and sides of prothorax except spot in front of tubercles, spot on tegulae, lateral lines and pair of large discal marks anteriorly on scutum, fascia on scutellum narrowed, sometimes interrupted medially, fascia on metanotum, curved fascia on dorsum of median seg-

ment continued medially downward on its posterior surface, sides of median segment entirely or in part, lateral angles of same, metapleurae, mesopleurae, and mesosternum almost entirely, broad fasciae on tergites 1-5, the first broadly and squarely emarginate anteriorly in the middle, sometimes cut through leaving a medial spot as in the male, second with medial emargination usually narrow and much prolonged posteriorly to right and left, third to fifth with more shallow emarginations, which have their posterior middle notched with yellow, apex of ultimate tergite, first sternite entirely, fasciae on 2-5 broadest on two and narrowest on five, apex of ultimate sternite, legs except spot on coxae, trochanters, and femora, above and rarely spot on tibiae above, and tarsi, *lemon yellow*, the color somewhat deeper on the legs than elsewhere.

Length.—12-15 mm.

The flagellum below varies from yellow to testaceous, and above from testaceous to black. In most specimens the mesopleurae and mesosternum are wholly yellow; on a few the mesosternum is more or less black, and on two it is entirely black. The second and third sternites may be entirely yellow or may show more or less of a black basal border.

In both sexes the wings are hyaline and the veins fuscous. The pubescence is short, sparse, and not conspicuous. On the male the markings are lighter than on the female and are not so extensively developed. The fasciae on the tergites are narrower on the male than on the female, and the emarginations are broader and apparently deeper. On one male from Kansas all the tergal fasciae are continuous, and below the yellow color is as extensive as on the brightest of the females. This species is remarkable in the superficial resemblance of the female to *Steniolia duplicata* Provancher.

Habitat.—Virginia, North Carolina, Missouri, Kansas, Texas, New Mexico, Arizona, and Lower California (Handlirsch).

Number of specimens examined.—Males, 5; females, 15.

STICTIELLA FORMOSA Cresson.

Figs. 47, 48, 81, 97, 98.

Monedula formosa CRESSON, Trans. Amer. Ent. Soc., vol. 4, 1872, p. 221, female, male.

Monedula speciosa HANDLIRSCH, Sitz. Akad. Wissenach. Wien, Math.-Nat. Cl., vol. 99, 1890, p. 140, male, female.

? *Monedula speciosa* FOX, Proc. Acad. Nat. Sci. Phila., 1895, p. 366.

Monedula speciosa CAMERON, Trans. Amer. Ent. Soc., vol. 34, 1908, p. 236, male.

Male.—Black: Labrum, clypeus, mandibles except apices, scape, first and second flagellar segments below, entire frons except pit of anterior ocellus and pair of spatulate lines that run downward and inward from the vertex and are narrowly separated below the ante-

rior ocellus, posterior orbits broad below, narrow above, and may be prolonged on the posterior edge of the vertex, prothorax except a broad anterior dorsal spot undulate on its posterior border, which may be extended laterally almost to the tubercles or interrupted, leaving a pair of lateral spots, tegulae in large part, lateral lines on scutum forming with the curved fascia on the scutellum a continuous curved line, fascia on metanotum, curved fascia on dorsum of median segment produced on the posterior surface and narrowly interrupted medially, lateral angles broadly and sides of median segment, mesopleurae except curved line back of tubercles and spot in front of middle coxae, large spot on metapleurae, fascia on first tergite interrupted medially, its anterior border deeply, broadly emarginate medially and extended forward at the extreme sides, posterior border with a broad shallow emargination on either side of the midline, second fascia of similar pattern except that the anterior medial emargination is extended slightly to the right and left at the posterior angles, and the anterior lateral prolongation is divided showing a lateral black spot, third fascia similar to second except that the median emargination is wider and shallower and the anterior lateral prolongation is interrupted, showing a lateral yellow spot, remaining fascia similar in pattern, but much reduced and modified, apex of seventh tergite, first sternite entirely or nearly so, large lateral spots on second, successively smaller lateral spots on sternites 3-5, coxae, trochanters except spot at base, femora except stripe above, tibiae except more or less of lower surface, tarsi except apical segments, *yellow*.

The flagellum is light below and beyond the second segment is of a ferruginous cast. Viewed from above it gradually increases in width from the base to the fourth segment, whence it gradually decreases toward the apex, and segments 3-10 appear very slightly carinate posteriorly, due to specialized areas on the posterior surface. The apical segment of the tarsi is black, dilated, and flattened. This is remarkably so of the anterior pair on which the claws are developed in a fashion peculiar to this species. On the middle and posterior tarsi the apical segment is not so greatly dilated and the claws are of the normal form. The middle femora are dentate on the posterior side; the middle tibiae are club-shaped, being dilated apically (fig. 97), and bear on the apex anteriorly a short, blunt, reddish spine. The middle metatarsus is strongly curved on the inner side, on which, near the base, it bears a number of spines, the most basal one being smallest. The second sternite is plain, without trace of carina or tubercle; the eighth ends in three spines.

Female.—Black: Labrum, mandibles except apices, clypeus, frons except a pair of broad spatulate lines running from the vertex downward and inward, broadly united on the middle of the face and enclos-

ing a Y-shaped spot below the anterior ocellus, scape and first segment of flagellum, second below, posterior orbits broad below and continued across the posterior border of the vertex, prothorax except a broad anterior dorsal spot undulate on posterior margin, tubercles, tegulae, U-shaped discal mark on scutum interrupted at posterior middle, broad lateral lines on scutum continuous with the broad curved fascia on scutellum, metanotum, curved fascia on dorsum of median segment, sides of same continued over lateral angles onto posterior surface, mesopleurae except curved spot behind tubercles and large spot in front of middle coxae and separated from its fellow by a broad median line on mesosternum, metapleurae, fasciae on tergites, all continuous and fashioned like those of the male, but lacking the lateral black spot on second and yellow spot on third, apex of ultimate tergite, first sternite except lateral spots, triangular spots on posterior lateral angles of sternites 2-5 successively smaller, apical edges of ultimate sternite, coxae, trochanters except spot above, tibiae except spot below, smallest or wanting on posterior pair, and tarsi, *yellow*. The posterior border of the middle femora is curved so that when seen from below the segment appears much wider in the middle than at either end. The middle tibiae are somewhat dilated apically, but much less so than in the male.

Length.—17-20 mm.

The wings in both sexes are hyaline, relatively short, and the veins are brown. The legs are strong and the tibiae and tarsi very spiny. The tarsal combs are strongly developed in the female but are practically wanting in the male. The pubescence is white, short, sparse, and inconspicuous even on the male. The color of the markings is a lemon yellow lighter on the head and abdomen than on the thorax and darker on the legs. The labrum, the apical half of the clypeus and the anterior orbits of the female are very light, almost white on one specimen. The lateral spots on the sternites may or may not be connected apically by narrow lines. One male is smaller and more slender than the other two; the thorax and median segment are immaculate above except for narrow broken line on scutellum; the extent of the yellow on sides of prothorax and sides of thorax and median segment is greatly reduced. The fasciae on the first three tergites are widely interrupted, leaving a pair of medial spots on two and three; the remaining three are more or less completely interrupted on either side the midline, leaving a median spot. Structurally it shows no variation whatever. Judging from Cameron's description of the male he referred to *speciosa*, his specimen must have been very similar to this one.

Handlirsch considered this species identical with *speciosa* Cresson and accordingly placed it as a synonym under that species. As far as I can discover it has been so regarded by others since that time, but

the specimens before me make it necessary to restore the species. Cresson's type of *speciosa*, a female, came from Colorado and his type of *formosa* from Texas. Both Handlirsch's and Cameron's specimens were all from Texas, and the descriptions indicate that they belong to Cresson's *formosa*. I have before me females from Colorado, Texas, and Kansas and males from New Mexico and Texas. The males from these two localities are structurally distinct as well as differently maculated, and those from New Mexico are so nearly like the female from Colorado in color and general appearance as to warrant, in my opinion, the assumption that they are sexes of the same species. Aside from the fact that the males in question are positively distinct, the color of the females and the pattern of their abdominal fasciae are sufficiently unlike to justify the contention that they belong to different species.

Habitat.—Texas, Kansas.

Number of specimens examined—Males, 5; females, 4.

STICTIELLA MELANOSTERNA, new species.

Figs. 49, 50, 82, 99.

Male.—Black: Labrum, mandibles except apices, clypeus except narrow basal border, lower part of frons, irregular V-shaped spot inclosing anterior ocellus, anterior orbits irregularly notched and reduced to a very narrow line above, comparatively broad posterior orbits extended for some distance on the posterior border of the vertex, prothorax except a median anterior dorsal spot, and a dusky spot anterior to tubercles, tegulae, broad lateral lines and a broken U-shaped discal spot on scutum, broad fascia on scutellum narrower medially, metanotum, broad curved fascia on dorsum of median segment extended in a pair of triangular points on its posterior surface, lateral angles including much of the posterior surface and all the sides of the median segment, metapleurae, mesopleurae, and mesosternum except a pair of large black spots in front of the middle coxae, broad fasciae on tergites 1-6, the first roundly or somewhat triangularly emarginate on its anterior middle and slightly biemarginate on its posterior border, second with anterior medial emargination somewhat extended at its posterior lateral angles and notched with yellow on the middle of its posterior border; the remaining fasciae with four anterior emarginations, the middle pair somewhat the larger and deeper, apex of ultimate tergite, broad continuous fasciae on all sternites, coxae except basal spot below, trochanters except more or less black above, femora except broad stripe on anterior pair above, tibiae, and tarsi, *bright lemon yellow*.

The ultimate segment of the antennae is curved and segments 5-11 are faintly carinate on the posterior surface. The middle femora are slightly angulated below near the base, and from this point to the apex extends a row of short stout spines. The middle metatarsi are

curved on the inner side and basally bear a group of spines, the more apical two being large and conspicuous. At the apical end of the curved surface are several smaller spines. The second sternite is plain and the eighth lacks a discal spine. Genital stipes as in figure 50.

Female.—The female is so similar to the male in color and maculations that a separate description is unnecessary. The following differences, however, are noted: Black basal border of clypeus is lacking; anterior orbits are broader; posterior orbits are connected across vertex; the U-shaped discal mark is usually interrupted on posterior middle; black spot anterior to middle coxae is quite small; lateral emarginations on anterior of fasciae on tergites 2-5 shallow and usually covered by the segment preceding; black on coxae wanting and reduced on trochanters; black stripe on all femora above; ultimate sternite yellow. A female from Arizona has the yellow much more extensive; the black spots on the sternum are reduced to mere points, the U on the scutum is broad and continuous, and the legs and sternites are wholly yellow.

In both sexes the flagellum is fulvous or yellowish-fulvous below, darkening toward the apex. The pubescence is short, sparse, and inconspicuous and the punctuation is of the usual character. The tarsal combs are strongly developed on female; weakly on the male. On both sexes the pulvilli are indistinct.

Length.—11-14 mm.

This species is characterized by its indistinct pulvilli, broad fasciae on tergites, yellow sides of thorax and median segment, and small size. It is described from six males and seven females. Of the females five are from New Mexico, one from Arizona, and one from Utah; the males are all from New Mexico.

Type.—Male. Cat. No. 19803 U.S.N.M.

STICTIELLA SERRATA Handlirsch.

Figs. 51, 52, 83, 100.

Monedula serrata HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 99, 1890, p. 143, male.

Monedula serrata Fox, Proc. Acad. Nat. Sci. Phila., 1895, p. 366.

Male.—Black: Labrum, mandibles except apices, clypeus except very narrow basal border, spot between antennae, small spot before anterior ocellus, scape, broad anterior orbits, posterior orbits, posterior dorsal border of pronotum, tubercles continuous with spot on sides of prothorax, spot on tegulae, feebly marked lateral spot above tegulae on scutum, large lateral spots on scutellum, fascia on metanotum, narrow border of mesosternum reaching upward to tubercles, fascia on first tergite reduced to widely separated rectangular lateral spots, remaining fascia narrowly interrupted medially, that on second tergite broadest and deeply and widely emarginate on anterior middle, those on 3-6 much narrower and slightly emarginate anteriorly on either side

the mid line, posterior lateral spots on sternites 2-6, which on some segments may be connected by an apical line, coxae and trochanters more or less, femora except stripe above on anterior and middle pairs and above and below on posterior pair, tibiae except stripe on anterior pair below, and tarsi, *yellow*. The antennae are slightly carinate posteriorly and the apical segment is curved. The middle femora are dentate below and the middle metatarsi are curved on the inner side, the curved surface bearing basally several rather large spines. The second sternite is plain and the eighth is without a discal spine.

Female.—Black: Labrum, mandibles except apices, lower half of clypeus, lower part of frons, spot before anterior ocellus, scape except a dusky spot above on some specimens, broad anterior orbits, posterior orbits, posterior dorsal border of pronotum, spot or line on sides of prothorax united with tubercles, spot on tegulae, short lateral lines on scutum above tegulae, large lateral spots on scutellum, fascia on metanotum, spot near lateral angles and another below the spiracle on median segment, fasciae on tergites 1-5 similar in all respects to those of the male except that some or all (except the first) may be continuous, posterior lateral spots on sternites 2-5, spot on anterior and middle coxae below, trochanters apically above, anterior and posterior borders of femora shortened basally on posterior pair, tibiae except more or less prominent dusky line below and usually also above on anterior pair, and tarsi, *yellow*. The apical sternite is black and the legs, especially the tarsi, are tinged with ferruginous.

Length.—11-13 mm.

In both sexes the flagellum is lighter below than above, especially the basal segments, and in the female, and slightly also in the male, is more or less tinged with ferruginous. The wings are somewhat strongly infumated, nearly as much so as those of *Stictia carolina*. On the female the pubescence is short, sparse, and inconspicuous; on the male short, rather dense, and conspicuous on the head, thorax, and more apical sternites. The pulvilli are indistinct on both sexes. One female bears a pair of discal marks on the scutum, and a male from Wisconsin has the fasciae on the tergites almost white.

Habitat.—Florida, Georgia, North Carolina, Wisconsin.

Number of specimens examined—males, 4; females, 5.

STICTIELLA PLANA Fox.

Figs. 53, 84.

Monedula plana Fox, Proc. Acad. Nat. Sci. Phila., 1895, p. 367, male.

Monedula usilata Fox, Proc. Acad. Nat. Sci. Phila., 1895, p. 371, female.

Male.—Black: Labrum, mandibles except apices, clypeus, lower part of frons, scape below, spot in front of anterior ocellus, broad anterior orbits, posterior orbits, posterior border of pronotum, tubercles, large spot on sides of prothorax, anterior part of tegulae, small lateral spot on scutum above tegulae, large lateral spots on scutel-

lum approximated medially, fascia on metanotum, small oblique spots on dorsum of median segment, the lateral angles more or less and spot on sides of median segment, all absent on the type specimen, narrow vertical line on anterior border of mesopleurae, fascia on first tergite broad laterally, interrupted and narrowed to a point medially, fasciae on tergites 2-5 narrowly interrupted medially or continuous, with broad, shallow, anterior, medial emargination deepest on tergite 2, on which the fascia is the broadest, fascia on tergite 6 broken or complete, lateral spots on ultimate tergite, lateral spots on sternites 2 and 3, which may be absent, spot below on anterior and middle coxae, anterior and middle trochanters apically, anterior and middle femora except stripe above, posterior femora distally, tibiae except spot below on anterior pair, and tarsi, *greenish yellow or yellowish-white*. The apical segment of the flagellum is curved; the middle femora bear below a number of spines; the middle metatarsi are slightly curved on the inner side, which basally bears a row of four rather stout spines and apically a few very short ones. The second sternite is plain and the eighth is without a discal spine.

Female.—Black: Labrum, mandibles except apices, lower border of clypeus, scape below, space between antennae, spot below anterior ocellus, broad anterior orbits, narrow posterior orbits, line, sometimes broken, on posterior dorsal border of pronotum, tubercles and line leading downward from them, spot on tegulae, lateral spots above them and a pair of small discal spots on scutum, fascia on scutellum interrupted medially, short fascia on metanotum, pair of oblique lateral lines on dorsum of median segment, small spot on lateral angles, and another on sides of median segment, fascia on first tergite, interrupted medially and broadly emarginate on anterior middle, fascia on 2-4 continuous, all broadly, and that on second deeply emarginate on anterior middle, fascia on fifth narrow and interrupted medially, minute lateral spots on second sternite, anterior femora below, middle and posterior femora distally, tibiae more or less above, *greenish yellow or yellowish white*.

In both sexes the flagellum is testaceous below, the wings hyaline, pulvilli indistinct, and pubescence short, sparse, and not conspicuous. The tarsi of the female except the anterior pair, which show some yellow markings, are dusky almost black in some specimens; the middle and posterior pairs, as in the male, are very slender with all the segments except the ultimate one provided at their distal ends with long straight spines. The tarsal combs on the anterior pair are well developed in the female, but in the male only feebly. The claws are very slender and but slightly curved.

Length.—12-14 millimeters.

Habitat.—Kansas, South Dakota.

Number of specimens examined—Males, 2; females, 3.

65008°—Proc.N.M.vol.52—17—8

STICTIELLA TUBERCULATA Fox.

Figs. 54, 55, 101, 102.

Stictia tuberculata Fox, Proc. Acad. Nat. Sci. Phila., 1895, p. 366.

Male.—Black: Labrum, mandibles except tips, clypeus except marginal line at base, scape and basal flagellar segments below, space between antennae, pair of minute spots below anterior ocellus, anterior orbits, posterior orbits, line on posterior border of pronotum, sides of prothorax almost entirely, elongated irregular spot on mesopleurae, large spot on metapleurae, spots on side of median segment, short lateral lines on scutum above base of wings, triangular lateral spots on scutellum approximated medially, fascia on metanotum, oblique lines on dorsum of median segment and spots on its posterior surface, larger part of lateral angles of same, fascia of first tergite broken into pair of spots broad laterally, fasciae on remaining tergites continuous, broadly emarginate medially on anterior border and slightly sinuate laterally, ultimate tergite and sternite apically, broad continuous fasciae on other sternites narrowed medially, legs except more or less black on trochanters, black lines above on all femora, and black ultimate segment of tarsi, *yellow*.

Length.—14 mm.

The ultimate segment of the antenna is longer than its immediate predecessor, narrowed somewhat distally, rounded at the apex, and distinctly curved. The middle femora are serrate; the middle tibiae are distinctly dilated distally, resembling those of *formosa* in this respect; the middle metatarsi are curved and bear a group of spines near the base; and the ultimate segment of all tarsi is black and that of the anterior pair is distinctly dilated. The dilation of the last segment of the anterior tarsus is not symmetrical, being much more prominent on the posterior than on the anterior border of the segment. The second sternite bears a prominent median process decidedly hirsute in character.

This is a well-marked and distinct species.

Habitat.—Nevada.

Number of specimens examined—Males, 2; females, 0.

Type.—In the collection of American Entomological Society of Philadelphia.

STICTIELLA CALLISTA, new species.

Figs. 56, 85, 103.

Male.—Black: Labrum, mandibles except apices, clypeus except narrow black basal border, lower part of frons prolonged upward between antennae and narrowly separated from a broad V-shaped spot enclosing the anterior ocellus, broad anterior orbits, scape below, broad posterior orbits connected across the vertex and produced downward on either side the mid line of the occiput, prothorax except

median anterior dorsal spot and dusky line in front of tubercles, tegulae, broad lateral lines and U-shaped discal mark interrupted on posterior middle on scutum, broad fascia on scutellum narrower medially, metanotum, broad curved fascia on dorsum of median segment produced medially in a pair of triangular points on its posterior surface, likewise its lateral angles broadly and sides entirely, metapleurae, mesopleurae, and mesosternum except spot in front of middle coxae, broad fasciae on tergites, first deeply and roundly emarginate on anterior middle, and somewhat narrowed medially on posterior border and acutely notched on the midline, second with a narrow transverse median spot on either side the midline, third, fourth and fifth each with a wide but not very deep emargination on anterior middle, which is squarely notched with yellow on its posterior middle, sixth slightly biemarginate on anterior border, apex of ultimate tergite, sternites entirely except median anterior black spots on sternites 3-6, which are hidden when the abdomen is slightly flexed, coxae, trochanters except spot above, femora except stripe above, tibiae except spot below on anterior pair, and tarsi, *bright lemon yellow*.

The middle femora are distinctly serrate below; the middle metatarsi are curved, and basally on the inner side bear three stout spines. The second sternite bears a prominent tubercle and the sixth apically on the median line bears a distinct, somewhat triangular hump or elevation. The eighth below is strongly hirsute, the middle spine is long, stout and curved, and a discal spine is wanting.

Female.—Black: Labrum, mandibles except apices, clypeus, lower part of frons prolonged upward between antennae and narrowly separated from a broad V-shaped spot about the anterior ocellus, broad anterior orbits reaching almost to the posterior orbits on vertex, scape except apical dusky spot above, broad posterior orbits connected across the posterior border of vertex, prothorax except median anterior dorsal spot, tegulae, lateral lines and broad U-shaped discal mark on scutum, broad fascia on scutellum, metanotum, median segment entirely except a narrow curved black border adjoining metanotum and narrow black lines bordering the oblique sutures on dorsum and posterior surface, sides, and venter of mesothorax and metathorax, broad fasciae on tergites 1-5, first with a median anterior bilobed black spot, second with a median elliptical black spot on either side the midline, third, fourth, and fifth biemarginate on anterior middle, first to fourth slightly notched on posterior middle, ultimate tergite except three black emarginations at base, sternites entirely except more or less black basally on 4-6, legs entirely except spots on trochanters and stripes on femora above *bright lemon yellow*.

Length.—18-20 mm.

On both sexes the flagellum is testaceous below with the first and second segments yellowish. The ultimate segment is conical at the apex and on the male is slightly curved. The pulvilli are indistinct in both sexes and the pubescence is decidedly short and sparse; the female is almost nude. The wings are hyaline and long, the veins brown. On both male and female the fasciae on tergites 1-5 are slightly notched on posterior middle and on the males the anterior emargination on the third fascia may take the form of a pair of median spots similar to those on the preceding fascia. On some males the clypeus lacks the black basal border and the posterior orbits may not be connected across the vertex. Two females from Arizona (collected by F. H. Snow), which I have referred to this species are extremely yellow; the prothorax, sides, and venter of mesothorax and metathorax, median segment, first four tergites, and the first two sternites, are entirely yellow. It is a beautiful species, and owing to its large size and bright colors it is not likely to be confused with any species except *tenuicornis*, from which it can be readily distinguished by the absence in this species of distinct pulvilli in both sexes, by the absence of long spines on the lateral areas of the ultimate tergite of the female and by the presence of the serrate femora and curved metatarsi of the middle legs and the unituberculate second sternite of the male.

Habitat.—New Mexico, Arizona.

Number of specimens examined—males, 4; females, 3.

Type.—Male, Cat. No. 19806, U.S.N.M.

STICTIELLA BITUBERCULATA, new species.

Figs. 57, 58, 86, 104.

Monedula tenuicornis Fox, Proc. Acad. Nat. Sci. Phila., 1895, p. 369, male (not female).

Male.—Black: Labrum, mandibles except apices, clypeus, scape below, lower part of frons, broad anterior orbits, broad V-shaped spot inclosing anterior ocellus, posterior orbits broad below but narrower above, a rather narrow line across the posterior border of pronotum, sides of prothorax except a dusky line in front of tubercles and a small round lateral spot above this line, tegulae, weak lateral lines above tegulae on scutum, lateral spots on scutellum, fascia on metanotum, curved fascia on dorsum of median segment, sides and lateral angles of same, metapleurae, mesopleurae almost entirely, mesosternum except small lateral spots in front and slightly above middle coxae, fasciae on tergites 1-6 are more or less perfectly broken into large rectangular lateral spots, and a pair of ellipsoidal medial posterior spots, apex of seventh tergite, sternites entirely except small lateral spots of first and small medial spots on 3-6, coxae, trochanters below, femora except broad stripe above, tibiae

except spot below on first pair and stripe on posterior pair, and tarsi, *yellow or yellowish white*.

The medial spots on the tergites are decidedly white, as are also those on scutellum and metanotum. The clypeus is a very light yellow and the head is narrower than the thorax. The flagellum, long and slender, is tawny yellowish below, darkening toward the apex; segments 5-11 are faintly carinate posteriorly and the ultimate segment is slightly curved. The pulvilli are large and distinct, the middle femora smooth, and the basal half of the middle metatarsi is curved on its inner surface, which is not beset with spines. The second sternite bears two distinct, closely approximated but not large tubercles and the eighth bears a prominent discal spine. The wings are hyaline and the veins fuscous. Pubescence and punctuation are of the normal character. Genital stipes as in figure 58.

Female.—Black: Labrum, mandibles except apices, clypeus, lower part of frons extended upward between antennae, scape except small spot above, basal segments of flagellum below, V-shaped spot inclosing anterior ocellus, broad anterior orbits, posterior orbits broad below, narrower above and prolonged upon vertex, posterior dorsal border and sides of prothorax, lateral lines on scutum, pair of longitudinal lines and pair of approximated spots on disk of scutum, fascia narrowed medially on scutellum, fascia on metanotum, broad curved fascia on dorsum of median segment, lateral angles and sides of same, fasciae on tergites 1-5 similar in pattern to those of the male but better developed and all continuous except the first, ultimate segment both above and below except at base, second sternite, broad fasciae on sternites 3-4 with shallow median emarginations, fascia on fifth biemarginate, legs except stripe above on femora and below on anterior tibiae, *yellow*. The color is much richer than that on the male. The flagellum above is dark; below and at the apex tawny. The wings are clear, less than twice the combined length of the thorax and median segment; the veins are brown.

Length.—18 mm.

Two males of this species before me differ greatly from the type in the extent of the maculations (but not at all in structure). The first, from the same locality as the type, is a trifle smaller; the yellow on the prothorax is much reduced; the dorsum of the thorax and middle segment is black except a pair of small lateral spots on the scutellum; there is an irregular line on the mesopleurae, a spot on the metapleurae and another on sides of median segment; the paired median spots on the dorsum of the abdomen are separated from one another and from the lateral spots on all segments except the sixth; and the black on the sternites and on the legs is somewhat more extended. In a word, the maculations on the specimen are reduced.

On another, a specimen from Arizona, the maculations are better developed than on the type; the spot inclosing the anterior ocellus is united with the yellow on the frons below; the posterior orbits extend in a broken line across the vertex; the prothorax except for a median anterior dorsal spot is wholly yellow; there are lateral yellow lines and a broken U-shaped discal mark on the scutum, a fascia on the scutellum, another on metanotum, and a curved fascia on dorsum of the median segment, which is extended on its posterior surface; the lateral angles broadly and the entire sides of the median segment, the mesopleurae, metapleurae, and the mesosternum are wholly yellow; the paired median spots on dorsum of abdomen are all united with the lateral spots and those on tergites 2 and 3 are united medially, thus forming continuous, though deeply emarginated, fasciae; and the black on the legs and sternites is much reduced.

This species is characterized by a narrow head, the basally curved middle metatarsi destitute of spines, the pair of tubercles on the second ventral and the paired spots almost white in color on the dorsum of the abdomen. This species stands close to *emarginata*, from which it can be readily distinguished by its abdominal maculations and by the fact that the second cubital cell is almost square. In my judgment Fox erred in considering this species as the male of *tenuicornis*, and my reasons for so thinking are stated in my discussion of that species.

Habitat.—California, New Mexico, Arizona.

Number of specimens examined—Males, 5; females, 1.

Type.—Male, Cat. No. 19804, U.S.N.M.

STICTIELLA EMARGINATA Cresson.

Figs. 59, 60, 87, 105.

Monedula emarginata CRESSON, Proc. Ent. Soc. Phila., vol. 4, p. 468, female and male.

Monedula mamillata HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 99, 1890, p. 146.

Male.—Black: Labrum, mandibles except tips, clypeus, apical part of frons, scape below, usually a very small spot before anterior ocellus, broad anterior orbits, narrow posterior orbits, pair of transverse spots on posterior border of pronotum, spot on tegulae, lateral spots on scutellum, usually a narrow fascia on metanotum, rather narrow fasciae on tergites 1-6, first usually reduced to widely separated lateral spots, second sometimes narrowly interrupted medially and widely and shallowly emarginate on anterior middle and sometimes prolonged forward on either side the emargination, third, fourth, and fifth usually continuous and the anterior emargination reduced to undulations, sixth usually broken into three spots, apex of ultimate tergite, lateral spots or continuous fasciae on sternites 2-5, fascia on 6, femora apically more or less, tibiae except frequently spot below, and tarsi, *yellow or yellowish white*.

The four males before me show an unusual amount of variation both in the maculations and in the color of same. On one specimen the body markings are decidedly white; on others bright lemon yellow. On a specimen from Kansas the dorsal fasciae are comparatively broad and only the first is narrowly interrupted. On the same specimen there is a large spot on sides of prothorax. Another specimen from the same State shows a short pair of lateral lines on the scutum. The antennae show no special modifications; the middle femora are smooth below; the middle metatarsi are curved on the inner side medially and basally on the same side bear a row of about five or six comparatively stout spines. The second sternite bears a pair of short, pointed, prominent tubercles and the eighth a discal spine.

Female.—Black: Labrum, mandibles except apices, clypeus, space between antennae, scape below, very small spot in front of anterior ocellus extended slightly upon the vertex, very broad anterior orbits, moderately broad posterior orbits, pair of transverse spots on posterior border of pronotum, tubercles, spot on sides of prothorax, tegulae, usually short lateral lines above base of wings on scutum, lateral spots on scutellum narrowed medially and more or less approximated, fascia on metanotum, spot on sides near lateral angles of median segment, rarely small spot on metapleurae, broad fasciae on tergites 1-5, first interrupted medially and anteriorly deeply emarginate in the middle, in some specimens cut through in such fashion as to leave a median posterior pair of spots, fasciae 2-5 biemarginate anteriorly on dorsum of tergite, apex of ultimate tergite and sternite, lateral spots on sternites 2-5, and small median posterior spots on 3-4, *white or faintly yellowish white*. Femora more or less, tibiae except spot below, and tarsi, *yellow*. The tarsi are more or less testaceous, especially the posterior pair. The first and also the second segment of the flagellum may be yellowish below. On some specimens the median abdominal ventral spots are wanting; on others the lateral spots are connected by apical lines.

Length.—15-18 mm.

In both sexes the head is narrower than the thorax and the white, dense, rather short pubescence on the head, thorax and base of abdomen is somewhat better developed on the male than on the female. The pulvilli are distinct in both sexes. The wings are slightly infumated and the width of the second cubital cell on the radial vein is about half its width on the cubitus.

It seems highly probable that Handlirsch's *mamillata* is identical with this species, and I have so considered it. In his description of the male Cresson makes no mention of tubercles on the second sternite. I have, however, examined the specimens of this species in the collection of the American Entomological Society of Philadelphia,

among which is the type of the species, and the males there agree with the description given above. All specimens that I have referred to this species, both males and females, have the second cubital cell narrowed on the radial vein, and all the Males have the second sternite bituberculate, thus agreeing with Handlirsch's *mamillata*.

Habitat.—New Mexico, Colorado, Wyoming, Kansas.

Number of specimens examined—males, 9; females, 14.

STICTIELLA PULCHELLA Cresson.

Figs. 61, 62, 88, 106.

Monedula pulchella CRESSON, Proc. Ent. Soc. Phila., vol. 4, 1865, p. 471, female and male.

Monedula minutula HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 99, 1890, p. 148, female.

Male.—Black: Labrum, mandibles except apices, apical half of clypeus, pair of minute spots on frons below and between antennae, pair of spots laterad of the insertion of antennae prolonged upward as exceedingly narrow anterior orbits, comparatively broad posterior orbits, broken line on posterior border of pronotum, tubercles connected with an irregular spot on side of prothorax, spot on tegulae, small lateral spots on scutellum, narrow broken fascia on metanotum, spot on lateral angles and spiracles of median segment, spot on metapleurae, two small spots on mesopleurae, widely separated lateral spots on first tergite, continuous fasciae on tergites 2–6, that on second broadly but not very deeply emarginate on anterior middle, remaining fasciae biemarginate on anterior border and all with a notch on posterior middle, apex of ultimate tergite, continuous fasciae on all sternites, apical spot on coxae below, femora except stripe above and below, tibiae except stripe below on first and second pairs, and tarsi, *yellow*.

The eyes are distinctly divergent above. The middle femora are serrate below and the middle metatarsi are distinctly curved on the inner side and basally bear several spines. The second sternite bears a pair of small tubercles and the eighth lacks a discal spine.

Female.—Black: Labrum, mandibles except apices, clypeus, lower part of frons, curved spot below anterior ocellus, scape below, broad anterior orbits, posterior orbits broad below, posterior border of pronotum, sides of prothorax except line in front of tubercles, tegulae, lateral lines on scutum, fascia on scutellum narrow medially, fascia on metanotum, curved fascia on dorsum of median segment interrupted medially, lateral angles and nearly the entire sides of the median segment, metapleurae, mesopleurae, and mesosternum except large area in front of the middle coxae, continuous fasciae on tergites, first with a wide anterior medial emargination ending in three points posteriorly and with three shallow emarginations on posterior border,

second with a wide square medial anterior emargination, remaining fasciae slightly biemarginate on anterior middle, heart-shaped spot on apex of ultimate tergite, apical fasciae on all sternites distinctly narrowed medially on 5, apex of ultimate sternite, coxae, and trochanters below more or less, femora except broad stripe above and short stripe below on posterior pair, tibiae except spot below on first and second pairs, and tarsi, *yellow or yellowish white*.

Length.—14–16 mm.

On both male and female the flagellum is ferruginous above and fulvous below; the apical segment is curved, and in the male the posterior border of the flagellum is slightly carinate. The wings are hyaline, the veins fulvous. The pulvilli are indistinct. The fascia on the scutellum of one female is broken into spots similar to those on the male, the fascia on the median segment appears as faint oblique lines, yellow on mesosternum and mesopleurae much reduced, and the black on the legs present on all tibiae and below on posterior and middle femora. The frons and clypeus of the female show a silvery reflection; the eyes are widely separated and only slightly divergent above.

All specimens differ from the original description in that they show no trace of discal marks on the scutum, and the male has the base of the clypeus black.

Habitat.—California.

Number of specimens examined—Males, 17; females, 10.

STICTIELLA SPECIOSA Cresson.

Figs. 63, 64, 89, 107.

Monedula speciosa CRESSON, Proc. Ent. Soc. Phila., vol. 4, 1865, p. 470, female.
? *Monedula speciosa* PATTON, Bull. U. S. Geol. Surv., vol. 5, 1879, p. 361.

Male.—Black: Clypeus, labrum except an indefinite medial stripe, mandibles except apices, lower part of frons extended in a triangular area above insertion of antennae, semicircular spot below anterior ocellus, scape below, broad anterior orbits, posterior orbits broader below than above, prothorax except a broad anterior dorsal spot, tegulae, short lateral lines on scutum above tegulae, broad fascia on scutellum, narrow fascia on metanotum, broad curved fascia on dorsum of median segment extended down medially on posterior surface, sides of same entirely including lateral angles and much of posterior surface, mesopleurae except large spot below extended on mesosternum almost to the median line, metapleurae, fascia on first tergite broad laterally, interrupted narrowly in the middle, broadly emarginate on anterior middle and slightly on either side the posterior middle, fascia on second broad, continuous, inclosing a pair of median, elliptical, transverse, black spots and triundulate on posterior margin, fasciae on 3–6 broad, biemarginate on anterior margin

and undulate on posterior, apex of ultimate tergite, first sternite except small lateral spots, second except median longitudinal line, triangular lateral spots on 3-6, which may or may not be connected by apical lines, coxae, trochanters except spot above, femora except line on first and traces of line on second above, tarsi except all ultimate segments, *pale yellow*, deeper in shade on the legs.

The flagellum is ferruginous below, shading to yellowish on the basal segments, and 3-6 bear inconspicuous specialized areas. The second cubital cross vein is decidedly curved, so that the width of the second cubital cell on the radial veins is much less than its width on the cubitus. The middle femora below are dentate. The tibiae are not dilated as in *formosa* and are provided on the anterior at the apex with a short, stout spine. The middle metatarsi on the inner side are curved and bear near the base a row of four stout spines, of which the two in the middle are largest. The ultimate segment on all tarsi is flat and black and on the anterior pair is greatly broadened, but the claws are of the normal form. The second sternite bears near its posterior margin a pair of short but conspicuous tubercles, and the eighth lacks a discal spine; the ultimate tergite basally bears a number of short lateral stout spines.

Female.—Black: Labrum, mandibles except tips, clypeus, scape, first two flagellar segments below, frons except a pair of widely separated points at base of clypeus and a large butterfly-shaped black spot on the middle, which may be connected laterally with the black of the vertex; large spot almost inclosing the anterior ocellus; broad posterior orbits extended across the posterior edge of vertex; prothorax except a broad anterior dorsal spot and a dusky line in front of tubercles, tegulae, lateral lines, and a U-shaped discal mark that may be narrowly interrupted at posterior middle on scutum, broad transverse fascia on middle of scutellum, fascia on metonotum, median segment entirely except a black fascia on anterior border, a short black vertical line on posterior surface and rather broad black bands bordering sutures on dorsum and posterior surface, pair of large spots on mesopleurae of which the anterior one may be prolonged on the front border of the mesosternum to the ventral midline, thence backward narrowly to spot in front of middle coxae, metapleurae, all tergites (except a medial, rounded, black emargination on the first, a narrow anterior black margin somewhat broader laterally and continuous with a small but deep black emargination on either side the midline on the second, a somewhat broader anterior black margin with broader, shallower emargination on either side the midline on third, fourth, and fifth, and black lateral spots on sixth), lateral spots on sternites 1-5, the posterior ones smallest, pair of spots on apex of ultimate sternite, coxae except basal spots, trochanters except spot above, femora except line above reduced on posterior

pair, tibiae, and tarsi except tips of middle and posterior pairs, *yellow or yellowish white*.

On the abdomen the markings are almost white, the color approximating Ridgway's *marguerite yellow*. On the thorax and median segment above and on the head the yellowish tinge is somewhat more apparent; it is still more conspicuous on the scape and sides of thorax and median segment, and the legs, except the coxae, are decidedly yellow. The under side of the flagellum is yellowish, changing to testaceous toward the apex. The ultimate segments of the tarsi are but slightly dilated, and that of the middle tarsi and all the segments of the posterior pair except the metatarsi are decidedly dusky above.

Length.—18–20 mm.

The wings in both sexes are hyaline and the nervures brown. The narrowing of the second cubital cell on the radial vein is less pronounced in the female than in the male. The pubescence is relatively short, moderately dense and white except on the vertex, where it assumes a brownish color. The head is somewhat narrower than the thorax, more evident in the male than in the female, and the inner margins of the eyes are approximately parallel. On the type (a female) there are fasciae on sternites 2–4; on the female from Kansas the lateral spots on sternites 1, 2, and 6 are united on the midline. The fasciae on the tergites of the male are narrower than those of the female, and the first is interrupted medially, but in design they are quite similar.

In the discussion of *formosa* it is pointed out that that species has been regarded as identical with this, but it is very easy to separate the males on structural differences, and, although the females lack these structural characters, their markings are just as distinctly different as are the structures on the males. On *formosa* all tergites except the last possess a black apical border; this black border is entirely wanting on *speciosa*. The apical tarsal segments of *formosa* are yellow; the middle and posterior pairs of *speciosa* are dusky, almost black. The fasciae on the tergites of *formosa* are yellow; on *speciosa* they are almost white.

Habitat.—Colorado, New Mexico, Kansas.

Number of specimens examined: Males, 2; females, 4.

STICTIELLA MELAMPOUS, new species.

Figs. 65, 66, 108.

? *Monedula speciosa* PATTON, Bull. U. S. Geol. Surv., vol. 5, 1879, p. 361.

Male.—Black: Labrum, mandibles except apices, clypeus, scape, and first two segments of the flagellum below, lower part of frons produced upward between antennae, curved spot in front of anterior ocellus, broad anterior orbits, narrow posterior orbits, prothorax

except broad anterior dorsal spot with undulate posterior border and a line in front of tubercles enlarged at inner end, tegulae, narrow line above base of wings on scutum, lateral spots on scutellum narrowed toward the median line, narrow fascia on metanotum, pair of broken oblique lines on dorsum of median segment, lateral angles and spot near spiracle of same, metapleurae, small spot on mesopleurae behind the tubercles and another large one on anterior border that meets its fellow on the midline of the mesosternum, spot on mesosternum between middle coxae, broad, widely separated lateral spots and a pair of small median posterior spots on first tergite, narrow fasciae on tergites 2-5 continuous except that on tergite 2 and all biemarginate on anterior middle, sixth with a large median and small lateral spots, apex of ultimate tergite, lateral spots on sternites 2-5, coxae except basally, trochanters apically below, femora except stripe above on first pair, tibiae, and tarsi except ultimate segment on first and second pairs, and the last three segments on posterior pair, *yellow*.

The flagellum is testaceous below and slightly carinate posteriorly; the apical segment is reddish, much lighter than the others, slightly flattened apically, neither curved nor truncate, and somewhat longer than the segment immediately preceding. The middle femora are serrate below and the middle metatarsi are distinctly curved on the inner side and basally bear three spines, of which the distal two are large and prominent. The apical segment of all tarsi is *black*, dilated, flattened, and rounded apically, those on the anterior pair being dilated most, those on the posterior pair least, on which pair the third and fourth segments also are dark above and below. The pulvilli are large and distinct. The second sternite bears a pair of low, rounded, and somewhat widely separated tubercles and the eighth lacks a discal spine. The seventh tergite bears at the extreme lateral edges an inconspicuous ridge, from below which spring a number of short, stout spines. The pubescence is white, short, and moderately dense on head, thorax, and base of the first segment of the abdomen; the remaining segments are scarcely pubescent at all and show a beautiful bluish-violet iridescence.

Length.—15 mm.

The second specimen lacks the medial spots on the first tergite, but has a pair on the second and third. On the fourth and fifth they are united medially, and on the fourth also with the lateral spots. It also lacks the broken lines on the dorsum of the median segment and has all the femora striped with black above.

This species stands quite close to *speciosa*, with which it agrees in respect to the special structures of the legs, the tubercles on the second sternite, and the lateral spines on the ultimate tergite. It differs from *speciosa*, however, in that the second cubital cross vein is

scarcely curved, and consequently the second cubital cell is narrowed but little on the radial vein. Furthermore this species is much smaller and more slender and the pattern of its maculations is entirely different. It is my conviction that it was a male of this species that Patton in Bulletin 5, United States Geological Survey (p. 361), described as the male of *speciosa*.

Described from two males collected by Mr. F. X. Williams, August, 1911.

Habitat.—Seward County, Kansas.

Type and Paratype.—Collection of University of Kansas.

STICTIELLA VILLOSA Fox.

Figs. 3, 67, 68.

Monedula mamillata Fox (not Handlirsch), Proc. Cal. Acad. Sci., (2) vol. 4, 1893, p. 10.

Monedula villosa Fox, Proc. Acad. Nat. Sci. Phila., 1895, p. 370, male.

Male.—Black: Labrum, mandibles except apices, clypeus, scape and basal segments of flagellum below, space between insertion of antennae, spot on either side anterior ocellus, broad anterior orbits, posterior orbits broader below than above, prothorax except median anterior dorsal spot and spot before tubercles, tegulae, short lateral line above tegulae and pair of anterior discal spots on scutum, large lateral spots on scutellum, fascia on metanotum sometimes interrupted medially, spot on sides of median segment, metapleurae, large spot on mesopleurae in most specimens continuous with a longitudinal median mesosternal stripe that may be reduced to a median spot in front of middle coxae, broad fasciae on tergites 1-6, the first deeply and somewhat roundly emarginate on anterior middle, second, third, and fourth more widely and successively less deeply emarginate on anterior middle, fifth and sixth slightly waved, but not emarginate, apex of ultimate tergite, sternites entirely except black anterior lateral spots on 1 and 2, a narrow median anterior black spot on 3 and 4 and a narrow anterior black border on 5 and 6, spot on all coxae below, trochanters apically more or less, femora except stripe above, tibiae, and tarsi, *bright greenish yellow*.

Length.—10-13 mm.

The clypeus is almost white, faintly tinged with greenish yellow. The fasciae on the first four tergites posterior to the medial emargination are also white—a character that is constant and in degree varies only slightly on the first fascia. The flagellum varies below from greenish yellow basally to testaceous apically. The head, thorax, basal joints of the legs, including the femora, and the base of the abdomen, are densely covered with long, shaggy, white pubescence—a character that distinguishes this species from all others herein listed. The legs show no special modifications and the pulvilli are large and

distinct. The second sternite in some specimens bears a pair of tubercles rather poorly developed but quite distinct; in other specimens this sternite lacks these tubercles entirely. The eighth bears a prominent discal spine. The wings are hyaline and very long, reaching almost to the end of the abdomen and being more than twice as long as the thorax and middle segment together. Variation in the extent of the maculations is slight, yet there is some reduction in the size of the spots on the thorax and median segment. When the abdominal segments are closely drawn together the venter appears almost entirely yellow.

Habitat.—New Mexico, Arizona, Mexico.

Number of specimens examined—Males, 11; females, 0.

STICTIELLA SCITULA Fox.

Monechula scitula Fox, Proc. Acad. Nat. Sci. Phila., 1895, p. 369, female.

Female.—Black: Labrum, mandibles except apices, clypeus, scape, flagellum below, frons except a median black spot (shaped somewhat like an expanded butterfly), connected laterally above with a transverse black stripe across the vertex, from which a stripe occupies the pit of the anterior ocellus, broad posterior orbits broadly connected across the vertex, prothorax, tegulae, broad lateral lines and U-shaped discal mark, which may be broken into three spots, on scutum, large lateral spots on scutellum approximated medially, fascia on metanotum, broad curved fascia on dorsum of median segment, broad lateral angles and sides of median segment, sides and venter of thorax entirely except the narrow lines of the sutures, broad fasciae on tergites 1-5, first with a median anterior black spot, which in some cases is connected with the black on base of segment, second, third, and fourth with wide, shallow, median, anterior emargination, slightly extended backward at the posterior lateral angles, especially on the second, fifth with anterior border undulate, apex of ultimate tergite, sternites entirely, legs entirely, *bright lemon yellow*.

Length.—10-11 mm.

The flagellum is testaceous above, lightest at apex. The clypeus and labrum are much lighter in color than the rest of the body markings. The region posterior to the base of the mandibles, frons above the antennae, and the vertex are provided with long, dense, white pubescence; the pubescence of the thorax and base of the abdomen is shorter and more sparse. Altogether the pubescence is more conspicuous on this species than is common on females of this genus. The pulvilli are large and distinct. The wings are hyaline, long, reaching nearly to the end of the abdomen, and fully twice the length of the thorax and median segment combined. The species is of normal form, but in the case of many specimens the abdomen is abnormally contracted, and it was from specimens of this kind that the

original description was made. The unusual development of the pubescence on this species and on *villosa*, the similarity of the wing venation of the two and their common habitat raise the question as to whether this may not be the female of that species. I should not be surprised if later investigation should prove such to be the case.

Habitat.—New Mexico, Arizona.

Number of specimens examined—Males, 0; females, 16.

STICTIELLA TENUCORNIS Fox.

Figs. 69, 70, 90.

Monedula tenuicornis Fox, Proc. Acad. Nat. Sci. Phila., 1895, p. 368, female.

Male.—Black: Labrum, clypeus, mandibles except apices, inferior part of frons, large spot about anterior ocellus connected by a vertical line with the yellow of the frons below, broad anterior orbits, posterior orbits continued somewhat on the posterior border of vertex, prothorax except median anterior dorsal spot, broad lateral lines and U-shaped discal mark, which may be broken, on scutum, tegulae, fascia on scutellum broad laterally, metanotum, broad, curved fascia on dorsum of median segment, lateral angles broadly and sides of same, metapleurae, mesopleurae and mesosternum except small spot in front of middle coxae, broad fasciae on tergites 1-6, the first squarely and deeply emarginate on anterior middle and deeply and triangularly emarginate on either side of the posterior middle, second with a transverse, arcuate, medial, anterior black spot and three shallow posterior emarginations, third with a narrow medial anterior emargination greatly extended to right and left on middle of tergite and with three posterior emarginations, the middle one deepest, fourth, fifth, and sixth similar to third, but with anterior emargination modified and posterior black border reduced, apex of ultimate tergite, first and second sternites entirely, broad fasciae on 3-6 narrowed medially and sometimes also laterally, coxae except spot on posterior pair below, trochanters except spot above, femora except stripe above, tibiae, and tarsi, *bright lemon yellow*, of deeper shade on the legs.

Female.—Black: Labrum, clypeus, mandibles except apices, scape and basal segments of flagellum below, frons below, V-shaped spot in front of anterior ocellus, broad anterior orbits, posterior orbits broad below and extended on vertex, sometimes entirely across, prothorax except medial anterior dorsal spot, tegulae, lateral lines and U-shaped discal mark, sometimes broken into three spots, on scutum, fascia on scutellum narrowed medially, metanotum, broad fascia on dorsum of median segment prolonged medially on posterior surface, its sides, lateral angles, and most of its posterior surface, metapleurae, mesopleurae, mesosternum except spot in front of middle coxae, broad

fasciae on tergites 1-6, first with a deep rectangular emargination at anterior middle and three slight emarginations on posterior border, second with an elliptical black spot near the middle on either side the median line and three slight posterior emarginations, third similar to second, but with two black spots narrowly united to an anterior medial emargination, fourth and fifth on anterior margin dorsally biemarginate and laterally waved, ultimate tergite except narrow anterior border, first and second sternites entirely, third entirely or with only a central anterior black spot, fourth and fifth with rather broad fasciae narrowed medially and laterally, ultimate sternite apically, coxae, trochanters except spot above, femora except stripe above, tibiae except sometimes a stripe below, and tarsi, *lemon yellow*.

Length.—16-18 mm.

The flagellum in both sexes is slender, and the apical half is testaceous below. In the male the apical half is carinate on the posterior side and the ultimate segment curved. The intermediate femora of the male are smooth beneath and the metatarsus not curved. The second sternite is nontuberculate and the eighth is without a discal spine. In color and markings the sexes are remarkably similar and the different specimens show but little variation from the typical form. On the first tergite the emargination may appear as an anterior rectangular black spot or it may be connected with the posterior emargination so as to cut off a pair of posterior median yellow spots or a single yellow spot. On the second on both male and female we usually find a single median black spot that may or may not be connected by a narrow medial emargination with the anterior black border. Other slight modifications may occur but the basic pattern remains the same, the variations being due to a greater or less extension of the black on the dorsal surface. The lateral borders of the ultimate tergite of the female, especially toward the base, are provided with numerous stout spines. The wings are hyaline and relatively long; the pubescence short and sparse, and the labrum, clypeus, and anterior orbits of the female show a silvery reflection when viewed at the proper angle. In his description of this species Fox associated as male and female of the species a male that I regard as representative of a different species entirely. I base this judgment on the fact that males I have before me and the female of Fox's *tenuicornis* are so similar that they can be distinguished only by their sexual characteristics, whereas the male Fox assigned to this species differs from the female not only in color and widely in the pattern of the markings, but also in having the head narrower than the thorax. I have accordingly considered the male as representative of a new species and have redescribed it herein under the name *bituberculata*.

Habitat.—California, Arizona, Texas.

Number of specimens examined—Males, 3; females, 7.

STICTIELLA MEGACERA, new species.

Figs. 71, 72, 91.

Male.—Black: Labrum, mandibles except apices, clypeus, scape except narrow line above, first two flagellar segments below, lower part of frons, V-shaped spot below anterior ocellus, broad anterior orbits, posterior orbits, narrow posterior dorsal border and sides of prothorax except narrow line in front of tubercles, tegulae, short lateral lines above base of wings on scutum, large lateral spots on scutellum, short fascia on metanotum, lateral angles and sides of median segment, metapleurae, broad irregular line on mesopleurae and mesosternum meeting on the middle of the latter and prolonged backward to the middle coxae, fasciae on tergites, first broad laterally but widely and deeply emarginate on anterior middle, biemarginate on posterior border and almost interrupted on midline, second broad with a narrower anterior median emargination, of which the posterior lateral angles are strongly produced obliquely laterally, third with broad, shallow, anterior, median emargination, the remainder with slightly undulate anterior borders, apex of ultimate tergite, first sternite, second except irregular anterior border, remaining sternites with broad fasciae (which, when the abdomen is strongly flexed, cause the sternites to appear entirely yellow), coxae, trochanters except spot above, tibiae, and tarsi, *yellow*.

The flagellum is dark above, reddish below. The second segment widens apically and the third is still broader; from the fourth to the apex the width decreases imperceptibly. The ultimate segment is slightly curved and somewhat flattened apically. The legs are relatively short and unusually stout. The middle femora are decidedly short, thick and heavy and are smooth below; the middle metatarsi are also unusually short, thick, and heavy and show no trace of curve or spines on inner surface. The posterior are likewise unusually thick, heavy, and rounded and when seen from in front are plainly arcuate, the hollow of the bow being on the upper side. The pulvilli are large and distinct. The wings are hyaline and a trifle over twice as long as the combined length of the thorax and median segment. The pubescence is white, moderately long, and dense on head, thorax, and base of abdomen; it is somewhat shorter and less dense yet quite evident on all sternites and very short and sparse on tergites. The second sternite bears a very large median spine, very heavy at the base, bluntly pointed and hirsute. The terminal spines of the eighth are very short and a discal spine is lacking.

Female.—Black: Labrum, mandibles except tips, clypeus, scape below, greater part of flagellum below, lower part of frons, V-shaped spot below anterior ocellus, broad anterior orbits, posterior orbits

narrow above, narrow line on posterior border of pronotum, greater part of sides of prothorax, tegulae, narrow lateral lines on scutum, large lateral triangular spots on scutellum, fascia on metanotum, curved fascia on dorsum of median segment narrowly interrupted on posterior surface of segment, lateral angles and sides of same, large spot on metapleurae, small posterior and larger anterior spot on mesopleurae the latter of which extends downward to join its fellow on the sternum and forming with it a longitudinal band that reaches the middle coxae, fasciae on tergites, first broad laterally but deeply and widely emarginate on the anterior middle, nearly interrupted on mid-dorsal line, and slightly biemarginate on the posterior border, second with lateral sinuations and broad median emarginations on anterior border, third with anterior lateral sinuations and dorsally biemarginate, fourth and fifth undulate on anterior border, apex of sixth broadly, broad fasciae on sternites, the more posterior ones narrowed medially, coxae, tochanters and femora except broadly above, tibiae, and tarsi, *yellow*, the color being very pale on the labium, clypeus, orbits, and fasciae of the tergites.

The flagellum is dark, testaceous above, yellow below, basally becoming somewhat rufous apically. It does not show the broadening of the medial segments seen on the male. The legs are relatively short and stout, the middle metatarsus being similar to that of the male. The second cubital cell is almost a perfect rectangle. The pubescence is like that on the male.

Length.—14–16 mm.

Described from two males and one female; one male from Arboles, Colorado, second male from Iron County, Utah, and the female from North Yakima, Washington.

Type.—Male in the Brooklyn Museum. Allotype and paratype, Cat. No. 19805, U.S.N.M.

STICTIELLA EXIGUA Fox.

Figs. 73, 74, 92.

Monedula exigua Fox, Proc. Acad. Nat. Sci. Phila., 1895, p. 370, female.

Male.—Black: Labrum, mandibles except apices, clypeus, inferior part of frons, curved spot on either side the anterior ocellus, almost inclosing it, scape except apical spot above, broad anterior orbits narrowed to a point above, posterior orbits more or less perfectly connected across the posterior of vertex, prothorax except small anterior median dorsal spot, lateral lines and a pair of large discal spots on scutum, broad fascia roundly emarginate on anterior middle or narrowly interrupted on midline on scutellum, metanotum, broad curved fascia on dorsum of median segment, lateral angles broadly and sides of same, metapleurae, mesopleurae, and mesosternum except narrow anterior black border and large lateral black spot on front and

above the middle coxae continued upward along the suture between the mesopleurae and metapleurae, broad fasciae on tergites, first with a broad rounded shallow emargination on anterior middle, second to fifth each with a wide and very shallow anterior emargination on either side the dorsal midline, apex of ultimate tergite, sternites 1-3 entirely, broad apical fasciae on 4-6, legs entirely except spots above on trochanters and femora basally, *yellow*. The legs are of the normal form, without any special modifications. The second sternite bears a pair of closely placed, sharply pointed, prominent tubercles, and the eighth a prominent discal spine.

Female.—Black: Labrum, mandibles except apices, clypeus, frons below, pair of curved spots almost inclosing anterior ocellus, broad anterior orbits narrowed to a point above, scape, posterior orbits continuous on vertex, prothorax, tegulae, broad lateral lines and pair of broad discal lines narrowed posteriorly on scutum, scutellum, metanotum, dorsum of median segment except curved black fascia on anterior border, lateral angles, sides and almost all the posterior surface of median segment, metapleurae, mesopleurae, and mesosternum except lateral spots in front and slightly above middle coxae, tergites except shallow median anterior black emargination on first, narrow anterior black border on remainder, slightly waved on 3-5 and notched on 6, sternites entirely except basal border of 5 and 6, legs entirely except basal spots above on trochanters, and femora, *yellow*. The clypeus, labrum, and frons are decidedly silvery, the sides of the thorax less so, and even the venter of the abdomen shows a trace of this.

In both sexes the flagellum is cylindrical in form, testaceous above, yellowish or testaceous below, and lighter in the female than in the male. The silveriness of the face and sides of the thorax is less evident in the male than in the female. The pubescence is short and inconspicuous. The wings are hyaline and the veins brown. The pulvilli are distinct.

Length—9-13 mm.

The description above is made from two males and one female collected by F. H. Snow, in Arizona. A comparison with Fox's type of *exigua* convinces me of their identity, although the markings on these specimens are somewhat more extensively developed than are those on the type which is a female from Montana.

This species stands very close to *Stictiella pulla* Handlirsch, from which it is distinguished chiefly by the more extensive maculations.

Habitat—Arizona, Montana.

STICTIKELLA PULLA Handlirsch.

Figs. 75, 93.

Monedula pulla HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 99, 1890, p. 149, female.

Monedula usitata Fox, Proc. Acad. Nat. Sci. Phila., 1895, p. 371, male.

Male.—Black: Labrum, mandibles except apices, lower part of clypeus variable in extent, scape below, space between insertion of antennae, minute spot on either side of anterior ocellus, anterior orbits, posterior orbits, posterior border of pronotum, tubercles and narrow lines on border of side of prothorax, tegulae, lateral spot on scutum above tegulae, large lateral spots on scutellum, fascia on metanotum, curved fascia on dorsum of median segment sometimes reduced to two spots or entirely wanting, spiracle and spot on sides of median segment usually extended on lateral angles, spot on metapleurae, irregular spot on mesopleurae, broad fasciae on tergites 1–6, the first with broad, shallow, medial, anterior emargination, remainder with a shallow anterior emargination on either side the mid-dorsal line, ultimate tergite apically, first sternite except anterior lateral spots, the remaining sternites except narrow basal border varying somewhat in width on the several sternites, coxae except base more or less, trochanters below, femora except broad stripe above and below which stripes are united on posterior pair, tibiae except spot below on anterior and middle pairs and occasionally on posterior pair, and tarsi, **yellow**. The antennae and legs show no special modifications. The second sternite bears a pair of short approximated processes and the eighth a prominent discal spine.

Female.—The female, with regard to general appearance and pattern of maculations, is essentially like the male. The black on the clypeus is wanting or reduced to small basal lateral spots; that on the legs is somewhat more extensively developed. The yellow markings are somewhat brighter in color and slightly better developed; on one female there is a pair of small discal spots on the scutum. Aside from these differences in color and the absence of the secondary sexual modifications found on the male, the description above will apply to the female also.

Length—10–14 mm.

In both sexes the flagellum below is yellowish or testaceous, decreasing in intensity toward the apex. The black on the clypeus of the male is variable in extent; it is never entirely absent and it never spreads over the entire clypeus. On both male and female the clypeus appears somewhat silvery, more evident on well-preserved specimens of the female than on the male. The fasciae on the tergites of the male show two distinct shades of color, lemon yellow and yellowish white, somewhat variable in their arrangement; this

diversity of shade in the fasciae is less apparent on the female owing to their deeper and brighter color. The apical segment of all tarsi on the female is longer than the two preceding segments together, is heavy, not flattened, rectangular in outline and thickly beset with stout hair below; on the male this segment is more slender, conical and comparatively shorter. The pulvilli on both male and female are large and distinct and the pubescence is not at all conspicuous. The wings are hyaline and the form of the three cubital cells, identical in the sexes.

I have associated here as sexes of one species Handlirsch's *pulla*, a female, and the male of Fox's *usitata*. I have done this for the following reasons: The pattern of their maculations is almost identical; the pulvilli are large and distinct in both cases; the form of the third cubital cell is peculiar and common to both; they are of the same size and are found in the same locality. The female of Fox's *usitata* has indistinct pulvilli, the sternites wholly without fasciae, and the form of the third cubital cell is distinctly different from that of the male he associated with it. Furthermore, I am convinced that the female referred by Fox to his *usitata* is the female of his *plana*. The character of the pulvilli, the maculations and the habitat all point to this conclusion.

Habitat.—California, Washington.

Number of specimens examined—males, 12; females 8.

STICTIELLA FEMORATA Fox.

Figs. 76, 77, 94, 109.

Monedula femorata Fox, Proc. Acad. Nat. Sci. Phila., 1895, p. 363, male.

Male.—Black: Clypeus, labrum, mandibles except apices, scape below, spot in front of anterior ocellus and inferior part of frons, separated by a butterfly-shaped spot that above is broadly connected laterally with the black of the vertex, broad anterior orbits shortened above, narrow posterior orbits, posterior border of pronotum connected on tubercles with a large spot on sides of prothorax, small spot on tegulae, small spot near tegulae on scutum, lateral spots on scutellum, metanotum, curved fascia on dorsum of median segment more or less broken, irregular spot on mesopleurae extending on the mesosternum, small spot on metapleurae, spot on lateral angles of median segment, fasciae on tergites 1-6 narrowly interrupted medially, apex of ultimate tergite, fasciae on sternites 1-6, legs except upper side of coxae, trochanters, femora and more or less of the posterior tibiae, *yellow or yellowish white*.

The flagellum is testaceous beneath except the more basal joints, which are yellowish; segments 6-11 seen from below are distinctly carinate on the posterior border and the apical segment is flattened

and curved. The pulvilli are distinct; the anterior tarsi are unusually flat and broad, the apical segment less so, and each segment below bears a black spot. The medial femora are strongly emarginate below and bear a slight notch beyond the emargination. The hind femora are also more or less emarginate below, sometimes taking the form of a slight dilation of the segment apically beyond the middle. The second sternite is bituberculate.

Female.—Black: Clypeus, labrum, mandibles except apices, scape except small spot above, semicircular spot in front of anterior ocellus and lower part of frons separated by a black butterfly-shaped spot that above is broadly connected laterally with the black of the vertex, posterior orbits usually united across the vertex, posterior border of pronotum including the tubercles, sides of prothorax except spot in front of tubercles, tegulae, lateral lines above tegulae and medial longitudinal discal lines which may be continued posteriorly to form a more or less broken U-shaped mark on scutum, curved fascia on scutellum, narrowed medially, fascia on metanotum, continuous curved fascia on dorsum of median segment, lateral angles of same, mesopleurae and sternum almost entirely, spot on metapleurae, spot on side of median segment anteriorly, fasciae on tergites continuous and rather broad, the first with a broad shallow anterior emargination, the remainder slightly waved anteriorly but not emarginate, medial spot on apex of ultimate tergite, middle and narrow apical margin of first sternite, fasciae on sternites 2-5, that on second broad and deeply emarginate anteriorly, apex of ultimate sternite, legs below except spot on middle and posterior coxae, and above except spots on all coxae, trochanters, femora, and posterior tibiae, *yellow or pale yellowish white*. The flagellum is testaceous below. The middle femora are short and stout; the posterior femora are incrassate near the middle; the apical segment of the anterior tarsi is not dilated so much as that of the male; the pulvilli are present but small.

Length.—9-12 mm.

Of the four male specimens before me one, the type specimen, is from Florida, and three are from Texas. The specimens from Texas differ from the type in that the emarginations of the middle and posterior femora are less pronounced. One of the males from Texas is somewhat smaller than the type. In his description Fox states that the intermediate metatarsus is curved, which statement can scarcely be considered accurate; the segment is bent quite near the base but it is not curved as is that of *serrata* or *speciosa*. It is, however, near the base slightly dilated on the anterior margin and somewhat roundly incised on the inner side in much the same fashion as is the corresponding segment on the anterior tarsus. Furthermore the inner, posterior angle of the middle tibia is produced into a short

spine, which, with the incision on the metatarsus, forms a structure quite similar to the antenna cleaner invariably found on the first pair of legs of wasps and bees. In addition to the two prominent processes on the second sternite of the type specimen, there is a smaller and more widely separated pair on the third and an inconspicuous pair on the fourth. These secondary ventral processes are also more or less well developed on the other males.

In both sexes the wings are hyaline, short, and scarcely reach the posterior border of the third abdominal segment. The veins are brown. The pubescence is short, white, and not conspicuous. The male of this species can scarcely be confused with that of any other except *divergens*, from which it can be distinguished by the more extensive maculations of the latter and particularly by the form of the genital stipes. The peculiar modification of the middle femora, the unique structure found at the union of the middle tibia and metatarsus, and the presence of secondary processes on sternites three and four separate this species and the one following from all others. Length, 9–12 millimeters.

Habitat.—Florida, Texas.

Number of specimens examined—Males, 4; females, 5.

STICTIELLA DIVERGENS, new species.

Figs. 78, 79, 95, 110.

Male.—Black: Labrum, mandibles except tips, clypeus, scape, flagellum below, lower part of frons extended upward between antennae, irregular semicircular spot below anterior ocellus, broad anterior orbits shortened and narrowed to a point above, narrow posterior orbits, posterior border of pronotum, sides of prothorax except irregular spot in front of tubercles, tegulae, lateral lines and pair of discal lines (absent on paratype) on scutum, fascia on scutellum, curved fascia on dorsum of median segment narrowly interrupted medially, lateral angles and spot at spiracles on median segment, spot on metapleurae, mesopleurae almost entirely, mesosternum entirely, fasciae on tergites 1–6, first broad laterally, narrower medially with deep acute anterior median emargination, remaining fasciae somewhat narrower medially than laterally and slightly sinuate (those on tergites 4–6 of paratype narrowly interrupted medially), apex of seventh tergite, second sternite except pair of small anterior lateral black spots, continuous fasciae on sternites 3–6 the more posterior ones narrowest, legs entirely except black spots above on trochanters and basally on femora and conspicuous black spots on all segments of the anterior tarsi below, *bright yellow*. The more posterior fasciae on the abdomen both above and below are, however, yellowish white.

The flagellum is testaceous above and segments 6-10 are slightly carinate on the posterior surface. The ultimate flagellar segment is curved and obliquely truncate at the apex. The wings are hyaline and the second cubital cell is decidedly narrower on the radial vein than it is on the cubitus. The anterior tarsus is somewhat flattened but scarcely as much so as in the case of *femorata*, and like that species it has a distinct black spot below on anterior tarsal segments. The middle femora are emarginate and the middle tibia apically on the posterior side bears a short spine, which in conjunction with flattened and slightly curved base of the metatarsus forms a structure somewhat similar to the antenna cleaner of the first pair of legs. The posterior femora are slightly curved below and distally incrassate, but they are not emarginate. The second sternite bears a pair of short, pointed, closely approximated tubercles, and there is a smaller, inconspicuous pair on each of the third and fourth sternites more widely separated than those on the second. The pubescence is white, short, and sparse, except on the seventh sternite, where it is relatively long, dense, and brown. The eighth sternite lacks a discal spine, but there is a longitudinal prominence at the base of the middle spine. The genital stipes is distinct in pattern.

Length.—12-14 mm.

This species stands very close to *femorata* Fox, but it differs from that species in its more extensive maculations, its richer yellow color, and especially in the form of the genital stipes. The species is described from two male specimens taken by Mr. F. X. Williams.

Habitat.—Kansas.

Type.—Male and paratype in the collection of the University of Kansas.

Genus *BICYRTES* Lepeletier.

Bembex OLIVIER (part), Encycl. Meth., vol. 4, 1789, p. 288.

Monedula DAHLBOM (part), Hym. Eur., vol. 1, 1845, p. 492.

Bicyrtes LEPELETIER, Hist. Nat., vol. 3, 1845, p. 53.

Type: *Bicyrtes (servillii)* Lepeletier *ventralis* Say. Monobasic

Bembidula BURMEISTER, Bol. Acad. Cordova, vol. 1, 1874, p. 122.

Type: *Monedula discisa* Taschenberg. (Present designation.)

Bembidula HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 98, 1899, p. 473.

Bembidula KOHL, Die Gatt. d. Spheg., 1896, p. 442.

The head seen from in front is wider than long. The compound eyes are large and strongly arched; their inner borders are somewhat divergent at the vertex, and their lower borders reach the mandibles. The frons is relatively flat, variable in width, and bears a slight carina between the antennae. The anterior ocellar cicatrice is situated on a slight prominence. It is linear, arcuate, and transversely placed. The posterior cicatrices are also linear but not so narrow as the anterior one, semicircular, and almost longitudinally placed. The

occiput is quite narrow and the posterior surface of the head vertical and flat. The temples are narrow. The mandibles on their anterior border are entire; on their posterior border they are provided with two teeth and the apex ends in a point. The maxillae are moderately long, and when folded at rest they are concealed beneath the labrum. The maxillary palpi are formed of six segments and the labial of four. The labrum is about as long as broad at the base, somewhat arched from side to side and broadly rounded at the apex, not emarginate. The clypeus is broad and arched and its lower border is slightly curved.

The antennae are inserted on the frons on either side of the median carina a short distance above the base of the clypeus. They consist of 12 segments in the female and of 13 in the male. In the case of the males of some species some of the flagellar segments show secondary sexual modifications that are of use as characters in the distinguishing of species. The first flagellar segment (pedicel) is about as thick as long and the second exceeds any of the following ones in length.

The dorsum of the thorax is comparatively flat and the collar is placed much below the level of the scutum. The tubercles do not reach the tegulae. The suture between the sternum and episternum of the mesothorax is obliterated. The surface of the metapleura is almost at right angles to the long axis of the body and as a result its junction with the side of the median segment forms a depression into which the femora of the middle leg is drawn when at rest. The median segment shows a clearly defined dorsal middlefield which extends down upon the posterior surface of the segment. In a manner that is characteristic of the species of this genus the lateral angles of the median segment are extended, strongly compressed and wedge-like, and consequently the posterior surface of the segment from side to side is conspicuously curved or concave. The tergites are arched, the sternites flat, and in general the abdomen appears relatively longer and more slender than in *Bembix*. In the case of the female of some species the ultimate tergite bears a more or less well defined pygidial area set off by lateral ridges. The eighth sternite of the male, concealed beneath the seventh, ends in three spines instead of one as in *Bembix*. On none of the species so far recorded from North America north of Mexico do we find processes on the sternites of the males. The male genital apparatus consists of a short basal piece that subtends the long, strongly hirsute, weakly chitinized, lateral stipites, variable in form among the species, the median cleft spatha, which, seen from above, ends in a prominent rectangular dilation, and below the spatha the sagittae. Each sagitta is composed of two parts; the inferior part is straight, relatively slender, weakly chitinized and hirsute; the superior part is curved somewhat, strongly chitinized

and enlarged at the distal end. This enlargement resembles somewhat a truncate spoon, the concave surface being faced inward toward the midline.

Front wing.—The pterostigma is vestigial. The apical end of the radial cell is rounded off and lies on the costal border. Of the three cubital cells the first is about as long as the second and third combined. The first cubital cross vein is almost straight; the second is almost sigmoid in shape; and is far from parallel with the first so that the second cubital cell is much narrower on the radial vein than on the cubital, on which it receives both discoidal cross veins. The third cubital cross vein is quite strongly directed outward and roundly curved at its posterior end so that the rounded apical end of the third cubital cell frequently extends beyond the end of the radial cell. The angle formed by the radial and third cubital cross veins and opening outwardly is acute. The second discoidal cross vein posterior to its junction with the cubital is angularly bent outward and subtends at the angle a short longitudinal vein. The first submedian cell is as long or longer than the second, which gradually increases in width toward its apical end. The basal vein arises proximal to the terminus of the first submedian cell.

Hind wing.—The retinaculum, consisting of an unbroken row of small hooklets, begins near the origin of the radial vein, which extends distally almost to the apical border of the wing. The median cell is extremely long. The cubital vein arises distal to the terminus of the submedian cell. The posterior angle of the submedian cell, formed by the submedial and submedial cross veins, is, like that of *Steniolia*, obtuse. The submedial vein terminates in the anal sinus. The wings, particularly the anterior pair, in both sexes of many species are more or less infumated, the infumation being more evident in the female than in the male of the same species. The character and the degree of infumation is of value in the separation of species.

The legs are relatively long and slender. The middle coxae are not contiguous, and on the inner distal margin of the hind pair of some species there is a distinct tooth. The middle femora of the males of some species are compressed below to a sharp edge and in others there is present basally below a prominent, flattened tooth. The middle tibia at the distal end is provided with a single spur. The anterior tarsus of the female is flattened and provided with a strong tarsal comb; in the case of the male, with the exception of a few species, the anterior tarsus is not flattened and the tarsal comb is but weakly developed. The pulvilli are well developed and the claws simple.

The pubescence is short and sparse, not at all prominent except on the vertex. The punctations are evident, fine, and usually uni-

form, and their character and distribution on certain areas are used as specific characters, but such use is not wholly satisfactory. The ground color is black, frequently showing iridescence. The maculations are usually yellow but the shade of yellow varies greatly among the different species, in some almost white, in others very dark and in still others it may be tinged or replaced by ferruginous.

Bicyrtes differs from all related genera in the character of the posterior surface and the lateral angles of the median segment. Furthermore, it differs from *Bembix* in the number of segments in the palpi, in the form of the ocellar cicatrices, in the character of the first cubital cross vein, the eighth sternite, the apex of the labrum, and the male genitalia; from *Microbembex* in the number of segments in the palpi, the character of the mandibles, the radial cell, and the ocellar cicatrices; from *Stenolia* in the number of segments in the palpi, the length of the maxillae, the ocellar cicatrices, and the form of the male genitalia; from *Stictia* and *Stictiella* in the form of the ocellar cicatrices, and the male genitalia.

The generic synonymy given above was called to my attention by Mr. Rowland E. Turner, who writes Mr. S. A. Rohwer as follows:

Bembidula ventralis Say. A specimen in our collection is labelled "*Bicyrtes servillei* Lep. compared with type by Spinola." If this is correct *Bicyrtes* has priority over *Bembidula*, but *servillei* will sink as a synonym.

On receipt of this information I made a careful study of Lepeletier's description of *Bicyrtes servillei* and am convinced that Spinola's comparison is reliable. I, therefore, feel fully justified in changing the name of the genus.

KEY TO SPECIES.

Males.

1. Posterior coxa with tooth on inner distal margin.....*fodiens*.
1. Posterior coxa without tooth.....2.
2. Middle femora with distinct tooth at base.....3.
2. Middle femora without tooth at base.....4.
3. Ultimate tergite black; fasciae on tergites narrow.....*ventralis*.
3. Ultimate tergite with lateral yellow spots; fasciae on tergites relatively broad.
parata.
4. Mesopleura more or less conspicuously marked with yellow.....5.
4. Mesopleura black.....7.
5. Anterior wings heavily clouded in the region of the first cubital cell....*viduata*.
5. Anterior wings without heavily clouded area.....6.
6. Fasciae on tergites attenuated medially; the posterior one more widely interrupted than the anterior one; sixth reduced to widely separated spots.
quadrifasciata.
6. Fasciae on tergites scarcely attenuated medially; the posterior one less widely interrupted than the anterior one; sixth almost or quite continuous..*annulata*.
7. Anterior wings with heavily clouded area in region of first cubital cell.....8.
7. Anterior wings without clouded area; infumation, if present, diffused.....9.
8. Dorsum of median segment unmarked; genital stipes as in fig. 123.....*gracilis*.
8. Dorsum of median segment with a more or less complete yellow fascia; stipes as in fig. 125.....*viduata*.

9. Flagellum black; fascia on sixth tergite wanting or reduced to widely separated lateral spots; genital stipes as in fig. 118. *quadrifasciata*.
9. Flagellum not wholly black; fascia on sixth tergite always developed and scarcely more widely separated than the other fasciae; genital stipes otherwise formed. . 10.
10. Scape, first two joints of flagellum and legs ferruginous; genital stipes as in fig. 127. *insidiatrix*.
10. Scape and first two joints of flagellum not entirely ferruginous; genital stipes otherwise; legs black and yellow or black and ferruginous. 11.
11. Legs black and ferruginous; markings deep yellow, frequently with dashes of ferruginous. *capnoptera*.
11. Legs black and yellow; markings pale or creamy yellow, with no trace of ferruginous. *mesillensis*.

Females.

1. Posterior coxa with tooth on inner distal margin. 2.
1. Posterior coxa without tooth. 3.
2. Fasciae on tergites narrow; ultimate tergite black. *fodiens*.
2. Fasciae on tergites broad; ultimate tergite yellow. *burmeisteri*.
3. Pygidial area on ultimate tergite bordered with distinct lateral ridges. 4.
3. Pygidial area and lateral ridges on ultimate tergite lacking. 5.
4. Mesopleurae black; scutum without discal marks; fasciae on tergites interrupted medially and the more posterior ones narrowed laterally. *capnoptera*.
4. Mesopleurae yellow or bearing more or less conspicuous yellow markings; scutum with a pair of discal marks; fasciae on tergites usually continuous, not narrowed laterally. *annulata*.
5. Mesopleurae black. 6.
5. Mesopleurae marked with yellow more or less. 7.
6. Flagellum for the most part, legs and apex of ultimate tergite ferruginous; fascia on first tergite broad and best developed. *insidiatrix*.
6. Flagellum black; legs black and yellow or black and ferruginous; apex of ultimate tergite black; fascia on first tergite narrow and least well developed. *ventralis*.
7. Ultimate tergite black; largest of the species. 8.
7. Ultimate tergite with lateral maculations; size similar to *ventralis*. 9.
8. Anterior wings with clouded area in region of first cubital cell; discal spots on scutum large and tinged with rufous. *viduata*.
8. Anterior wings not clouded; discal spots on scutum absent or present in the form of narrow yellow lines. *quadrifasciata*.
9. Fasciae on all or at least on the fifth tergite continuous; fifth sternite almost entirely yellow. *parata*.
9. Fasciae on all tergites interrupted; fifth sternite with a pair of scarcely connected lateral spots. *mesillensis*.

BICYRTES FODIENS Handlirsch.

Figs. 111, 112, 134, 135.

Bembidula fodiens HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 98, 1889 p. 497, pl. 2, fig. 14, male, female.

Male.—Black: Scape below, first and second joints of flagellum below, basal half of clypeus, abbreviated anterior and very narrow posterior orbits, posterior margin of pronotum including tubercles, tegulae, posterior lateral borders of scutum, pair of spots on scutellum, transverse fascia on metanotum, lateral angles of median segment,

fasciae on tergites 1-6, widely interrupted on first, continuous on second, interrupted medially on the remainder, lateral spots on sternites 2-5 connected by faint apical lines, tarsi, tibiae, and distal extremities of femora, *yellow*. Wings rather heavily infumated somewhat more so than the wings of *ventralis*. Dorsum of thorax and median segment finely, closely, and evenly punctured, punctures of mesopleura somewhat larger; ultimate tergite closely and more heavily punctured, punctures less numerous on the apical median area. Intermediate femora carinate below; short but evident tooth on inner distal margin of posterior coxae; second ventral abdominal segment bears a short but conspicuous basal median carina.

Female.—Resembles the male in general appearances and coloration, and likewise has the characteristic tooth on the inner distal margin of the posterior coxae. The ultimate sternite is carinate medially and the ultimate tergite bears a pygidial area set off by conspicuous lateral ridges and sparingly punctured. The ultimate sternite extends beyond the lateral margins of the tergite apically in the form of prominent rounded angles. This character distinguishes this species from all others except *burmeisteri*.

Length.—11-14 mm.

The variation in the markings or in their color, as far as it is possible to judge from the number of specimens at hand, is not great. All males and the one female have the labrum black and the clypeus yellow with the lower margin bordered more or less widely with black which is nearly divided by a V-shaped prolongation of the yellow above. On one male the black margin is reduced to an extremely narrow apical border. The scape and first two segments of the flagellum are yellow below or may be entirely yellow, the extent and the intensity of the black above being variable. The anterior orbits are broad but greatly shortened above; the posterior are very narrow. The thoracic markings are constant; the coxae and trochanters are invariably black; the black on the femora varies in the males somewhat and the posterior tibiae may also be more or less dusky. The tibiae and tarsi of the females may be also more or less ferruginous; the males show but little of this color. The lateral spots on the sternites may or may not be connected by narrow apical lines. The fascia of the second tergite is usually continuous, and when not so the interruption is very narrow. The fasciae posterior to the second are successively more widely interrupted medially, and the more posterior ones may also be abbreviated laterally, consequently appearing as lateral spots. On one male, however, all the fasciae on the tergites, even that on the first, are continuous.

Habitat.—Louisiana, Mississippi, Texas, Georgia, Florida, Kansas, and Wisconsin.

Number of specimens examined—Males, 8; females, 4.

BICYRTES BURMEISTERI Handlirsch.

Fig. 136.

Bembidula burmeister HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 98, 1889, p. 500.

Female.—Black: Labrum, clypeus, mandibles except apices, broad anterior orbits, posterior orbits, scape, first and second flagellar segments almost entirely, posterior border of pronotum and tubercles, tegulae, lateral borders of scutum, lateral spots on scutellum, short fascia on metanotum, several small spots on dorsum of median segment representing a suppressed curved fascia, lateral angles of median segment, fascia of first tergite broken into a pair of large lateral and a pair of small dorsal spots, broad continuous fasciae on tergites 2–5 deeply emarginate at anterior middle, ultimate tergite, small lateral spots on sternites 2–5 connected by narrow apical lines, apex of sixth sternite, femora above, tibiae, and tarsi, *yellow*.

The wings are distinctly though diffusely infumated. The flagellum below and its ultimate segment apically are yellowish. The coxae are more or less marked with yellow and the hind pair, as in *fodiens*, are provided with a distinct tooth on the inner apical margin. The ultimate sternite bears a longitudinal carina and the corresponding tergite a well-defined pygidial area set off by distinct lateral ridges. The sternite projects beyond the tergite in a manner similar to that of *fodiens*, but it differs in detail from that of *fodiens*. The pubescence is exceedingly short and sparse and the puncturing is rather coarse, close, and uniform; it is closest and finest on the scutum, more coarse and scattered on the sixth tergite.

Length.—15 mm.

I have but a single specimen at hand—a female taken at Brownsville, Texas, by J. C. Crawford.

BICYRTES VENTRALIS Say.

Figs. 4, 113, 114, 132.

Monedula ventralis SAY, Exp. St. Peters River, vol. 2, 1824, p. 336, male.

Bicyrtes servillii LEPELETIER, Hist. Nat., vol. 3, 1845, p. 53.

Monedula ventralis CRESSON (part), Trans. Amer. Ent. Soc., vol. 4, 1872, p. 220.

Monedula ventralis PROVANCHER, Faun. Ent. Can., 1883, p. 629, female, male.

Bembidula ventralis HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 98, 1889, p. 495.

Male.—Black: Scape of antennae below, broad abbreviated anterior orbits, narrow posterior orbits, posterior margin of pronotum including the tubercles, rounded lateral spots on scutellum, line on metanotum, lateral angles of median segment, narrow fasciae on tergites 1–5 narrowly interrupted medially, lateral triangular spots on sternites 2–5, distal extremities of the femora, tibiae except more or less of the posterior surfaces, tarsi, *yellow*. Face silvery when

viewed with light at proper angle; wings somewhat infumated; eyes divergent at vertex. Punctures of dorsal surface fine, close and even, those of median segment somewhat larger; punctures of mesopleurae and dorsal surface of last abdominal segment coarser and not so closely and evenly distributed. Joints 7-9 of flagellum prominently rounded out below; intermediate femur with a prominent tooth posteriorly at base; hind tibia with a carina on inner side of distal half.

Female.—In coloration and general appearance similar to the male with such exceptions as are pointed out below. The ultimate tergite is devoid of all traces of lateral ridges or of a pygidial area; on the ultimate sternite there is a median longitudinal carina.

Length.—10-16 mm.

This is the most widely distributed species in the United States. The color of the markings varies from deep intense orange-yellow, through lighter shades of yellow to light creamy white, and this variation in color is true for both sexes. There is great variation also in the extent of the markings. In the female usually the greater part of the clypeus is yellow, but in many specimens it is reduced to a small area near the base. In some specimens the yellow covers almost the entire clypeus, but even in such cases the apical margin is black. In the male the clypeus is usually black but in many specimens there are two small yellow spots basally and in others only one, which varies in extent. In the male I found the labrum invariably black; among the many females examined only four showed any trace of yellow on the labrum. The coxae, trochanters, and the greater part (basal) of the femora are black. The color of the tibiae and tarsi varies greatly, showing shades varying from yellow through ferruginous to almost black in a few specimens. The scutum is unmarked except that in some individuals there is a short line at the posterior lateral borders. Two females show on the dorsal surface of the median segment small yellow spots suggesting a suppressed curved line thereon. The fasciae on the tergites vary somewhat in width and on 3, 4, and 5 may be interrupted laterally; in the males this is frequently true for tergites 3, 4, 5, and 6. On the first tergite the fascia may be much reduced or wholly lacking, especially in the male. The lateral spots on sternites 2-5 in the female and 2-6 in the male may or may not be joined by faint yellowish apical bands.

Habitat.—Georgia, North Carolina, Virginia, Tennessee, Pennsylvania, New Jersey, New York, Connecticut, Massachusetts, Maine, Canada, Indiana, Michigan, Illinois, Wisconsin, Colorado, Washington, Oregon, California, and Texas.

Number of specimens examined—Males, 107; females, 126.

HICYTES PARATA Provancher.

Figs. 115, 116.

Monedula parata PROVANCHER, Add. Hym. Quebec, 1888, p. 416.*Bembidula parata* Fox, Proc. Acad. Sci. Phila., 1895, p. 353.*Bembidula meliloti* ROHWER, Ent. News, vol. 19, 1908, p. 376, male.

Male.—Black: Scape and first two joints of flagellum beneath, large spot on clypeus, frequently spot on base of mandibles, broad abbreviated anterior and narrow posterior orbits, posterior margin of pronotum including tubercles, tegulae anteriorly, lateral stripe on scutum at base of anterior wing, rounded lateral spots on scutellum, transverse fascia on metanotum, lateral angles of median segment, broad fasciae on tergites 1–6, the more anterior of which, and in some specimens all, may be narrowly interrupted medially, triangular lateral spots on apical tergite, lateral spots on sternites 2–6, which may or may not be connected by apical bands, tarsi, tibiae, and femora distally, *yellow* or *greenish yellow*. Wings clear; eyes divergent at vertex; punctures of dorsum of thorax fine, close, and even, those of median segment somewhat larger; punctures of mesopleurae and apical tergite coarser and less evenly distributed. Segments 6–10 of flagellum rounded out below; intermediate femora with tooth at base posteriorly; hind tibiae with carina on inner surface of apical half.

Female.—In general appearance and coloration similar to the male: Clypeus and labrum entirely, spot on mesopleura variable in size, usually pair of discal spots on scutum, more or less well-developed curved line on dorsal surface of median segment, fasciae on tergites 1–5 broad, all of which may be continuous, lateral spots on the entire surface of sixth tergite, lateral spots on sternites broadly connected, apical sternite usually in part, and sometimes entirely, *yellow*. Apical tergite without pygidial area or lateral ridges, apical sternite with faint longitudinal median carina.

Length.—12–15 mm.

The clypeus, on both males and females, may be wholly yellow or may have only a narrow apical border of black. In specimens on which all or only part of the fasciae on the tergites are continuous, such fasciae are more or less deeply emarginate anteriorly in the middle. The apical sternite of the male and occasionally of the female lacks the yellow spots; usually in the female these spots are large and may be confluent or the entire segment may be yellow. The extent of the yellow on the sternites of the female is variable. On one specimen the venter of the abdomen is almost entirely yellow; on another the bands on sternites 2–4 are almost interrupted medially, and on all the fifth is almost completely yellow.

This species was described by Provancher from a single specimen from California, and in view of the fact that this specimen was a female the following statement by Fox with regard to this species is not clear:¹

The maculation of this species is a much richer yellow than in *ventralis*, and the female, which has been heretofore unnoticed, is very much like the male and has a well developed pygidium.

As a matter of fact, the female has no pygidial area whatever and up to the time Fox published his Synopsis the male had not been described. The first account of the male is found in Rohwer's description of *B. meliloti*, which I consider identical with the male of *parata*, since it differs not at all from the latter in structure or in color pattern and since the series before me shows a well-marked gradation from the bright yellow at one extreme to the greenish white of *meliloti* at the other.

Habitat.—California, Washington, Arizona, and Utah.

Number of specimens—Males, 9; females, 6.

BICYRTIS QUADRIFASCIATA Say.

Figs. 117, 118.

Monedula quadrifasciata SAY, Expd. St. Peters River, vol. 2, 1824, p. 336, male, female.

Monedula sallei GUERIN, Icon. du Regne Anim., vol. 7, Insect, 1845, p. 437.

Bembidula quadrifasciata HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 98, 1889, p. 492.

Bembidula variegata FOX, Proc. Acad. Nat. Sci. Phila., 1895, p. 353.

Male.—Black: Scape below, apical border of clypeus variable in extent, medial stripe on labrum variable in width or sometimes wanting, spot on base of mandible, broad anterior orbits abbreviated above, narrow posterior orbits, posterior margin of pronotum, spot on side of prothorax, tubercles, pair of small rounded lateral spots on scutellum, lateral angles of median segment, fasciae on tergites 1-5 interrupted and attenuated medially, those on 4 and 5 shortened laterally, frequently lateral spots on 6, small lateral spots on sternites 2-5, small spot on anterior coxa below, distal ends of femora below most extensive on anterior pair, tibiae except stripe on posterior pair above, tarsi except tips of segments on second and third pairs, which are more or less dusky, *yellow*. Wings slightly infumated; legs without special structures.

Female.—Black: Scape below, clypeus except spot of variable size at base, labrum except sometimes the lateral borders, spot on base of mandible, broad anterior orbits abbreviated above, narrow posterior orbits, posterior margin of pronotum, spot on side of prothorax, tubercles, narrow lateral line on extreme sides of scutum, frequently

¹ Synopsis of Bembicini of Boreal America, Proc. Acad. Nat. Sci. Phila., 1895, p. 353.

a pair of discal marks on same, spot on tegulae, another on base of anterior wing, pair of lateral spots on scutellum, pair of spots on metanotum, occasionally a curved line on dorsal surface of median segment, lateral angles of same, one or two spots on mesopleura, fasciae on tergites 1-4 interrupted and narrowed medially, lateral spots on sternites 2-3, spot on anterior coxae below, stripe on lower surface of femora less extensive on posterior pair, tibiae, and tarsi, *yellow*; wings as in the male; apical tergite densely punctured laterally, more sparingly along the midline, lateral ridges short and feebly developed, pygidial area lacking; apical sternite with faint longitudinal median carina.

Length.—12-14 mm.

This is one of our largest and most easily recognized species. The ground color is decidedly black and shows a marked bluish iridescence. The color of the markings is pale or creamy yellow, sometimes tinged with orange, more rarely faintly greenish. The yellow of head, thorax, and legs is usually deeper than that of the abdomen. The scape of the antenna is always yellow below and the flagellum is always black, save that the apical joint in some females shows a trace of reddish. The flagellar segments of the male are not rounded out or prominent below, but joints 6-10 have flattened specialized areas beneath, most conspicuous on 6 and 7. The marking of the labrum varies greatly; on the female it is usually yellow with the lateral margins piceous, but in a few specimens it is entirely yellow and in about as many it is wholly black. In the male the labrum is usually black, but in some individuals only the lateral borders are black, and in a few it is entirely yellow. The clypeus is marked basally with a black spot that varies in size in both sexes and is usually more extensive in the male than in the female, but in all cases there is always more or less yellow on the apical border.

The line on the posterior border of the pronotum may be wanting, may be represented by two or more spots, or may be broad and conspicuous. The scutum may be immaculate, may have a small spot on each lateral margin, which in some cases takes the form of a rather broad lateral stripe, and in some specimens may bear a pair of short discal lines or spots. In specimens on which the markings are best developed a pair of lateral spots occurs on both scutellum and metanotum, and in extreme cases there is a more or less well developed curved line on the dorsal surface of the median segment. In such specimens the small spots on the mesopleura form one large confluent area, and a smaller spot may be present on the metapleura. All coxae may be more or less spotted with yellow. The color of the fasciae and spots on the tergites, together with their arrangement are the characters that best distinguish this species. The fasciae are broad at the sides and narrowed toward the median line, where they

are narrowly interrupted anteriorly, more widely posteriorly; the anterior ones well developed, the posterior abbreviated; present on 1-4 and sometimes 5 in the female, on 1-5 and sometimes 6 in the male. The lateral spots on the sternites vary in size and also in number. They are usually found on 2-4 in the female, but occasionally are present on 5; in the males on 2-5, but may occur on 6 or be reduced to 2-4. In the case of two very light females from Kansas the lateral spots are present on 1-5 and sternite 2 is almost entirely yellow.

The terminal tergite of the female lacks a pygidial area, but short, feebly marked lateral ridges are present. The apical sternite is longitudinally carinate on the median line and throughout its apical half it narrowly extends laterally beyond the tergite, which is roundly triangular apically.

Two males, which I have referred to this species, were collected by Mr. Ashmead in New Mexico and were referred by Fox to *B. variegata* Olivier. These males differ from the typical male of *quadrifasciata* only in the possession of more extensive maculations; in other respects, including the genitalia, there is no essential difference. *B. variegata* Olivier was described from South America, and the genital stipites of the male are quite different from those of *quadrifasciata*, as is shown by a comparison of figures 117, 118, 119 and 120, of which 119 and 120 represent the stipites of a male of *variegata* taken in Venezuela.

Habitat.—Florida, Georgia, Alabama, South Carolina, Virginia, Pennsylvania, New Jersey, New York, Connecticut, Indiana, Ohio, Wisconsin, Kansas, and New Mexico.

Number of specimens examined—Males, 28; females, 23.

BICYRTES ANNULATA, new species.

Figs. 121, 122, 137.

Female.—Black: Labrum, clypeus, mandibles except apices, scape except spot on upper side, first joint of flagellum below, second almost entirely, lower part of frons, narrow vertical line in front of anterior ocellus, broad anterior orbits, posterior orbits narrowed above, broad below, and extended somewhat upon the vertex toward the posterior ocelli, prothorax except narrow anterior border connected with spot in front of tubercles, tegulae, broad lateral lines on scutum, pair of discal spots on same, pair of large lateral spots on scutellum approximated at median line, metanotum, curved fascia on dorsum of median segment, lateral angles of median segment, mesopleurae almost completely, spot on metapleurae, broad fasciae on tergites 1-5, continuous but with an acute triangular emargination medially, fasciae on sternites 2-5 continuous, triangular lateral spots on ultimate tergite, ultimate sternite, and legs almost entirely, *bright yellow*. The coxae basally are more or less marked

with black; the trochanters and proximal ends of the femora are more or less suffused with ferruginous. The wings are very slightly infumated.

Male.—Black: Labrum, mandibles except apices, clypeus, spot between antennae, scape except spot above, basal segments of flagellum more or less, broad anterior orbits, narrow posterior orbits, posterior margin of pronotum broadly including tubercles, tegulae, lateral borders of scutum, pair of discal marks on same rarely absent, large lateral spots on scutellum, narrowly connected in one specimen, metanotum, curved fascia on dorsum of median segment more or less broken, lateral angles of medium segment, one or more spots on mesopleurae, fasciae on tergites 1-6 broad, narrowly interrupted medially, the first narrowed somewhat medially, fasciae on sternites continuous but greatly narrowed medially, spot on all coxae, remainder of legs except more or less of trochanters and base of femora, *bright yellow*. The wings are but slightly infumated, less so than in the case of *capnoptera*. The flagellum is somewhat ferruginous and without conspicuous modifications, although segments 4-11 bear specialized areas similar to those of *capnoptera*. The intermediate femora and the genital stipes are likewise similar to those of *capnoptera*.

Length.—14-16 mm.

This species stands close to *capnoptera* Handlisch, but differs from it in the presence of mesopleural markings, greater clearness of the wings and the better development of the abdominal fasciae. On the type (male) of the species the abdominal fasciae are broad and continuous, really forming continuous rings around the body, hence the name, *annulata*. On the allotype (female) all the dorsal fasciae are interrupted except the sixth. The ultimate tergite of the female bears a pair of well marked lateral ridges inclosing a pygidial area slightly rugose basally and sparingly punctate elsewhere. The lateral areas bear short scattered spines or bristles. The ultimate sternite throughout its apical half extends out laterally beyond the tergite as shown in figure 137. On the type the lateral areas of the ultimate tergite and the corresponding sternite are yellow, but in some specimens the ultimate segment is black both above and below, while in others the proportions of black and yellow vary.

Habitat.—Arizona, New Mexico, Texas.

Number of specimens examined—Males 4; females, 13.

Type.—Female in the collection of University of Kansas, *Paratype*, Cat. No. 19678, U.S.N.M.

BICYRTES GRACILIS, new species.

Fig. 123.

Male.—Black: Clypeus except narrow apical border, mandibles except tips, crescent shaped spot on frons below antennae, scape

below, broad anterior orbits shortened and narrowed above, narrow posterior orbits, posterior border of pronotum including tubercles, pair of short narrow discal lines on scutum, short lateral lines on same above base of anterior wing, spot on base of anterior wings, tegulae, pair of rounded lateral spots on scutellum, narrow transverse curved fascia on metanotum, lateral angles of median segment, fasciae on tergites 1-6 rather widely interrupted medially, triangular lateral spots on sternites 2-5, distal extremity and short longitudinal stripe on anterior and posterior edge of anterior femora, anterior tibiae except stripe on posterior surface and below, anterior tarsus above, extreme distal ends of middle and posterior femora, greater part of intermediate tibiae below, and part of the posterior tibia below, *yellow or slightly greenish yellow*. Anterior wings with a heavily infumated spot in region of first cubital cell.

The black color of the body is intense, shining and shows a beautiful bluish-violet iridescence. The punctures of the thorax are fine, close, and evenly distributed; those of the apical tergite somewhat larger, closely placed basally but more widely separated on the apex especially on the middle area. Antennae and legs show no peculiar modifications. The fascia on the first tergite is slightly shortened laterally, much attenuated medially, and more widely interrupted than the others; second slightly attenuated medially; third and fourth narrowed, and fifth and sixth interrupted laterally. The middle and posterior tarsi are almost black, the distal ends of the segments showing traces of ferruginous. The face when viewed at the proper angle shows a silvery reflection.

This species resembles quite closely the male of *viduata*, but it is smaller and more slender than that species, the markings are less well developed and the genital stipes are quite different.

Habitat.—Santa Rita Mountains, Arizona (coll. F. H. Snow.)

Number of specimens examined: Males, 1.

Type.—The collection of the University of Kansas.

BICYRTES VIDUATA Handlirsch.

Figs. 124, 125.

Bembidula viduata HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 98, 1889, p. 491, female.

Male.—Black: Clypeus, base of mandibles, frons below insertion of antennae, scape below, anterior orbits not reaching to vertex, narrow posterior orbits, posterior margin of pronotum including the tubercles, spot on tegula, narrow lateral line on either side the scutum above base of anterior wing, pair of discal spots on scutum near anterior margin variable in size, one or two spots on mesopleura, pair of rounded lateral spots on scutellum, transverse fascia on metanotum, more or less complete curved fascia on dorsal surface

of median segment, lateral angles of same, broad fasciae on tergites 1-6 interrupted medially, slightly attenuated medially on 1 and 2, and attenuated or interrupted laterally on 2-6, triangular lateral spots on sternites 2-5 joined by faint apical lines, tips of femora with short line extending inward on anterior and posterior surfaces of anterior pair, tibiae except a part or all of the posterior surface of the several pairs, anterior tarsi, *yellow*. Anterior wings with a heavily infumated spot in region of first cubital cell; antennae and legs without special modifications.

Female.—Black: Clypeus, base of mandibles, frons below antennae, scape below, anterior orbits not reaching to vortex, posterior orbits narrowed above, posterior margin of pronotum including tubercles, lateral lines on scutum, pair of large diamond-shaped discal spots on same anteriorly, large spot on mesopleura, pair of large rounded spots on scutellum, metanotum, curved fascia on dorsum of median segment, lateral angles of same, broad fasciae on tergites 1-5 interrupted medially, first greatly and second slightly attenuated toward median line and second to fifth attenuated laterally, triangular lateral spots on sternites 2-5, spot on anterior coxae, tips of femora with line both above and below on anterior pair, tibiae except more or less of posterior surfaces, anterior tarsi, *yellow*. Anterior wings with heavily infumated spot in region of first cubital cell; apical tergite without pygidial area, sparingly punctured medially, more closely laterally, especially at base, lateral ridges short and feebly developed; apical sternite with faint median carina.

Length.—16-18 mm.

In coloration the males and females of this large and handsome species are very much alike, the markings being a rich yellow in the females and creamy yellow in the males. But little variation is found. The clypeus is predominantly yellow; in the male it is almost invariably so and in the female the black is confined to the apical margin, where it forms a more or less conspicuous border, or may appear as two small median spots. The discal spots on the scutum, variable in size and form, show in the majority of specimens a decided rufous color, which color may also appear on the spots on the mesopleurae. The median segment bears on its dorsal surface a curved yellow fascia, broad and conspicuous in the female, much reduced in width or present as a series of spots in the male. The fasciae on the tergites are all rather widely interrupted. The first is much narrowed medially, the second less so. Contrary to the original description all these fasciae except the first and occasionally the last, reach the border of the segments even in the males, in which the fasciae are narrower than in the females. The lateral spots on the sternites may or may not be connected by narrow apical bands. The antennae of the male show no evident modifications but segments

5-11 of the flagellum bear on their lower surfaces specialized areas scarcely at all prominent and difficult to distinguish. The large size, conspicuous fasciae of the abdomen together with the thoracic markings, and the medial dark spot on the anterior pair of wings distinguish this species at once from all other members of the genus herein described.

Habitat.—Texas, New Mexico, Arizona, and probably Mexico.

Number of specimens examined—Males, 7; females, 8.

BICYRTES INSIDIATRIX Handlirsch.

Figs. 126, 127.

? *Monedula ventralis* CRESSON (part), Trans. Amer. Ent. Soc., vol. 4, 1872, p. 220.

Bembidula insidiatrix HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 98, 1889, p. 494, female, male.

Male.—Black: Clypeus except apical border, broad anterior orbits, narrow posterior orbits, posterior border of pronotum including tubercles, lateral stripes on scutum not reaching anterior border, usually a pair of discal lines or spots on same, pair of lateral spots on scutellum more or less approximated at median line, transverse fascia on metanotum, lateral angles of median segment, fasciae on tergites 1-6 narrowly interrupted medially, sometimes first or first and second continuous, lateral spots on sternites 2-3, *yellow*. Labrum, mandibles except tips, scape, first and second joints of flagellum, remainder of flagellum more or less, legs except coxae, *ferruginous*. Wings infumated about the same as the wings of *ventralis*. Intermediate femora carinate but not dentate.

Female.—Black: Clypeus except apical border, broad anterior and narrow posterior orbits, lateral lines on scutum not reaching the anterior border, usually a pair of discal spots or lines on same, pair of large lateral spots on scutellum, curved fascia on dorsum of median segment (sometimes absent), lateral angles of same, fasciae on tergites 1-5 narrowly interrupted medially, first or first and second continuous, lateral spots on sternites 2-4, *yellow*. Scape, first and second joints of flagellum, remainder of flagellum more or less, labrum, mandibles except tips and usually a spot on base, tegulae, apex of ultimate abdominal segment above and below, legs except coxae, *ferruginous*. Wings somewhat more heavily infumated than those of the male; ultimate tergite without a pygidial area or lateral lines; ultimate sternite faintly carinate.

Length.—12-14 mm.

The labrum and mandibles, especially among the males, may be black; the ferruginous markings elsewhere, especially on the legs, may vary from almost yellow to nearly black. The dark area on the clypeus always arises from the apical border, never from the base. The scape below may be more or less yellowish; the flagellum of the

male is for the most part black, that of the female largely ferruginous. One female bears a yellow spot on the mesopleurae. The facia on the first tergite is broadest and all are but slightly narrowed toward the median line; they do not reach the lateral edge of the segments and the more posterior ones may appear as elongated lateral spots.

The female of his species may be distinguished from the female of *ventralis* by the presence of the ferruginous markings on the legs, antennae, and terminal segment and also by the fact that the first abdominal fascia is the one best developed in this species and most reduced in *ventralis*; from *fodiens* and *capnoptera* by the absence of a pygidial area and lateral lines on the ultimate tergite. The male can be distinguished from *ventralis* by the absence of a tooth on the intermediate femora; from *fodiens* by the absence of a tooth on the posterior coxae, and from *canoptera* by the form of the genital stipes.

Habitat.—Texas, Florida, New Mexico.

Number of specimens examined—Males, 6; females, 5.

BICYRTES CAPNOPTERA Handlirsch.

Figs. 128, 129, 133, 138.

? *Monedula ventralis* CRESSON (part), Trans. Amer. Ent. Soc., vol. 4, 1872, p. 220.

Bembidula capnoptera HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 98, 1889, p. 497, pl. 2, figs. 7, 12, female, male.

Male.—Black: Labrum (in some specimens ferruginous, in others black), clypeus (may be wholly or in part black), scape below, basal joints of flagellum below, anterior orbits, narrow posterior border of pronotum continuous with tubercles and narrow line on side of prothorax, lateral lines on scutum above base of wings, tegulae, lateral spots on scutellum, fascia on metanotum, lateral angles of median segment, fasciae on tergites 1-6 all interrupted medially, the more posterior ones usually shortened or narrowed laterally, lateral spots on sternites 2-6, which may be connected by narrow apical lines, *yellow* more or less dashed or suffused with ferruginous. Legs ferruginous with the coxae and more or less of the basal part of the femora much darker, sometimes black.

Segments 4-11 of the flagellum have raised specialized areas on the posterior surface, which, when viewed from a certain angle, cause the flagellum to appear slightly carinate. The wings as in *ventralis* are strongly infumated. The femora of the second pair of legs are not toothed but are carinate and slightly angular at the base below.

Female.—Black: Clypeus, labrum usually, spot between antennae, scape below, basal segments of flagellum below, anterior orbits, narrow posterior orbits, posterior border of pronotum continuous with tubercles and line on side of prothorax, lateral lines on scutum above base of wings, lateral spots on scutellum, fascia on metano-

tum, lateral angles of median segment, fasciae on tergites 1-5 interrupted medially and the more posterior ones shortened laterally, lateral spots on sternites 2-5 usually connected by narrow apical lines, *yellow*, more or less dashed or suffused with ferruginous. The legs are ferruginous, the basal joints usually darker than other parts but not so black as in the male.

The flagellum is more or less ferruginous, especially below, but in some specimens it is almost entirely black. The wings are heavily infumated, especially in the case of specimens from Georgia. The sixth tergite bears a well-defined pygidial area, set off by distinct lateral ridges as shown in figure 138.

Length.—10-15 mm.

This species shows considerable variation. In the female the clypeus is invariably yellow, but the labrum varies from yellow through ferruginous to black; in the male the clypeus may be entirely yellow or entirely black, but is usually black with a yellow apical border. The labrum of the male is generally black. Variation in the maculations is less pronounced, though the dorsal markings on the abdomen of the females from Texas are much better developed than are those on the females from Georgia. On one female from Texas there is a small pair of discal marks on the dorsulum. In no case do we find the mesopleurae maculated in either sex and rarely the dorsum of the median segment.

Habitat.—Georgia, Texas, Kansas.

Number of specimens—Males, 9; females, 8.

BICYRTES MESILLENIS Cockerell.

Figs. 130, 131.

Bembidula capnoptera HANDLIRSCH, var. *mesillensis* COCKERELL, Davenport Acad. Nat. Sci., vol. 7, 1898, p. 142.

Bembidula mesillensis COCKERELL, Can. Ent., 1899, p. 255.

Male.—Black: Labrum, irregular spot on base of mandibles, apical half of clypeus, scape below, broad anterior orbits not reaching vertex, narrow posterior orbits, posterior border of pronotum including tubercles, narrow lateral lines on scutum above base of anterior wing, lateral spots on scutellum, transverse fascia on metanotum, lateral angles of median segment, comparatively broad fasciae on tergites 1-6 interrupted medially, the first broadest and slightly attenuated medially, the remainder attenuated but not shortened laterally, lateral spots on sternites 2-6 united by faint lines on apical margins of sternites, distal extremities of femora, most obvious on first pair, tibiae, and tarsi, *yellow*. First and second joint of flagellum yellowish below, remainder below ferruginous; wings slightly infumated, darkest at apical end of median cell of anterior wing; antennae with slightly prominent specialized areas on segments 4-12 below;

carina of intermediate femora and genital stipes similar to those of *capnoptera*.

Female.—Black: Labrum, mandibles except apices, clypeus, scape below, broad anterior orbits not reaching vertex, narrow posterior orbits, posterior border of pronotum including tubercles, lateral lines on scutum not reaching anterior margin, tegulae, spot on base of anterior wings, one large and two smaller spots on mesopleurae, rounded lateral spots on scutellum, transverse fascia on metanotum, four spots (a suppressed curved line) on dorsum of median segment, lateral angles of same, broad fasciae on tergites 1–5, interrupted medially, first greatly and second slightly narrowed medially, small lateral spots on ultimate tergite, triangular lateral spots on sternites 2–5 connected by narrow apical lines, spot on anterior coxae below, *pale creamy yellow*. Coxae (except anterior pair) and trochanters entirely black; femora with more or less of the distal part yellow; tibiae yellow with very dark spot below on first and second pairs; tarsi tawny yellow. Wings somewhat infumated, slightly darker than those of the male but not so dark as those of *ventralis*. The ultimate tergite lacks lateral ridges and a pygidial area.

Length.—15 mm.

A female from Texas has the mandibles and labrum black with faint pale yellowish markings basally; another, from Arizona, has a pair of discal spots on the scutum, small lateral spots on prothorax and a very large spot on mesopleurae. A male from Arizona has the labrum ferruginous, the yellow on the clypeus restricted to two lateral apical spots, a pair of small lateral spots on the dorsum of the median segment, and the black on the femora much reduced in extent and intensity.

The male of this species is very similar to the male of *capnoptera* Handlirsch with which it agrees with respect to the character of the intermediate femora and the development of the antennae. It differs from that species only in the color of its maculations and to a slight degree in the form of the genital stipes. The female, however, is quite closely allied to *parata* and *ventralis*, from which it may be distinguished only by the character and color of its maculations. It differs markedly from *capnoptera* in the absence of lateral ridges and a pygidial area. The association of a male and female of such divergent relationships as sexes of the same species without biological evidence to sustain it is open to question. I have retained them, however, as sexes of the same species since they have been so associated and since I have no data to show that such association is not the correct one.

Habitat.—New Mexico, Arizona, Texas.

Number of specimens examined.—Males, 4; females, 3.

Genus *BEMBIX* Fabricius.*Apis* LINNAEUS, Syst. Nat., ed. 10, vol. 1, 1758, p. 574.*Bembix* FABRICIUS, Syst. Ent., Char. Gen., 1775, No. 115.*Bembix* FABRICIUS, Syst. Ent., 1775, p. 361, No. 115.*Bembex*¹ FABRICIUS, Gen. Insect, 1776 (or 1777), p. 122.*Bembex* OLIVIER, Encycl. Meth., vol. 4, 1789, p. 288.*Bembex* FABRICIUS, Ent. Syst., vol. 2, 1793, p. 247.*Bembex* LATREILLE, Gen. Crust. et Ins., vol. 4, 1809, p. 97.*Monedula* DAHLBOM, Hym. Eur., vol. 1, 1845, p. 492.*Bembex* HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 102, Abth. 1, 1893, p. 663.*Bembex* KOHL, Die. Gatt. d. Spheg., 1896, p. 430.

Type.—*Apis rostrata* Linnaeus, designated by Latreille 1810, or more recently by Morice and Durant 1915.

The wasps belonging to this genus vary from 12 to 22 millimeters in length and are comparatively robust in build. The head is as broad as the thorax or even slightly broader in some species. The compound eyes are large, convex, naked, and the facets are of uniform size. The inner margins of the eyes are usually almost parallel, but in some species they diverge toward the vertex and in others toward the clypeus, consequently the shape of the frons is not constant in the genus. The lower margin of the eye reaches the base of the mandible. The anterior ocellar cicatrix is linear, transverse, and slightly curved; the posterior pair are also linear, not transverse, and more nearly semicircular. In at least two species the ocelli are fairly well developed and are probably functional. The occiput is very narrow and the precipitous posterior surface of the head is somewhat concave. The temples are moderately developed but not as broad as the eye seen from the side.

The mandible is well developed and the outer border is entire; the inner border bears one or two teeth, the development of which in a few species is decidedly weak. The apex ends in a single point. The maxillae are relatively long, but when folded at rest they are concealed beneath the labrum. The maxillary palpi consist of four segments, the labial of two. The labrum is beaklike, much longer than broad, and is deeply emarginate at the apex. In some species it bears a transverse impression above which it shows a slight median prominence. The clypeus is broad and convex and its distal margin curved. The antennae are inserted on the frons quite near its lower border and the distance between them is about equal to the distance from the antenna to the margin of the adjacent eye. The scape is thicker, heavier and usually, but not invariably, longer than any of the flagellar segments. The first segment of the flagellum (pedicel)

¹ This is an obvious emendation of the more correctly formed name *Bembix*. The mentioning of *Bembex signata* at the bottom of the page is intended to enlarge the generic description so as to include the species that were later separated into the genus *Stictia*, and can not be construed as limiting the genus to those species congeneric with *signata*.

is small, rounded, not longer than thick, and the second segment exceeds in length any of those following it. In the male, except in the case of a few species, the flagellum bears secondary sexual modifications that serve as specific characters. They consist of pits, spines, dilations, curvings, etc., on various flagellar segments.

The thorax is strong, compact, and flattened above. The prothorax is never strongly developed; the collar is much below the level of the scutum and the tubercles do not reach the tegulae. The sternum and episternum of the mesothorax are fused, leaving no suture. The junction of the metapleura and the side of the median segment forms a depression into which the femur of the middle leg is drawn when at rest. The median segment is short and its dorsal surface is lower than that of the thorax. The dorsal median area, or middle-field, is definitely set off by oblique sutures and is broadly continued down upon the almost vertical posterior surface of the segment. The lateral angles are usually somewhat prominent but are always rounded, never angular or wedge-like.

In general appearance the abdomen is relatively compact and robust, more rarely somewhat slender. The tergites are strongly arched, the sternites flat. The ultimate tergite of the female is somewhat conical in form, rarely with a pygidial area differentiated, for the most part hirsute and provided with short lateral spines near the base, usually punctate, but in a few cases more or less strongly rugose. The second sternite of the male may or may not bear a more or less well developed process, but the sixth, except in a very few species, always does so. The form of these processes affords specific characters. The seventh also varies in development and the eighth, which is concealed by the seventh, ends in a single spine.

The male genital armature consists of a short basal piece (*cardo*), which bears the lateral stipites, the median cleft *spatha* and below this the *sagittae*. The *stipes*, which alone is figured in the accompanying plates, and which should never be left out of consideration in the determining of species, is prominent and variable in form, according to the pattern of which the species may be separated into groups. Its variation in form among the groups is very marked. Its variation within the different groups is sometimes very slight, so that, unless it is supported by other characters, simply a slight variation in the form of the *stipes* can not be regarded as safe ground on which to separate species, for slight variations in the *stipes* occur among individuals that are manifestly members of the same species. The median cleft *spatha* terminates below in a pair of recurved hooks that vary in form among the species and at a short distance proximal to these hooks is a pair of short, sharply pointed, barb like teeth. Below the *spatha* lie the *sagittae*, each of which is composed of two parts, the one short, pointed, straight, and strongly hirsute; the

other longer, curved, laterally compressed, strongly chitinated, smooth, and variable in form at the apex.

In the majority of the species the wings are hyaline, but in a few species they are more or less strongly infumated, the infumation being less evident in the wings of the male than in those of the female of the same species. In the anterior wing the radial cell, pointed at the proximal end and blunt at the distal end, lies on the costal border. The first cubital cell is about as long as the second and third combined. The second cubital cell is narrower on the radial vein than on the cubitus and receives both discoidal cross veins. The first cubital cross vein in nearly all species just before it joins the cubitus bends strongly toward the proximal end of the wing. The third cubital cross vein is roundly curved outward toward the distal end of the wing and with the radial vein forms a right or obtuse angle opening toward the distal border of the wing. The second submedial cell is as long as the first, or a trifle longer, and gradually increases in width toward the distal end of the cell. The basal vein arises just proximal to the distal end of the first submedial cell.

On the posterior wing the retinaculum, as in related genera, is formed of an uninterrupted row of little hooklets beginning distal to the origin of the radial vein, which is prolonged and reaches almost to the distal border of the wing. The median cell is greatly elongated and from its distal end two short veins, the ends of the radius and cubitus, are extended, of which in some species one may be obliterated. The cubitus arises distal to the end of the submedian cell, which is long, and its posterior distal angle, formed by the submedian and submedian cross veins, is an acute or a right angle. The submedian vein terminates in the anal sinus. The basal lobe is oblong or oval and is approximately equal to one-half the length of the submedian cell.

The legs are well developed. The middle coxae are separated, the trochanters are comparatively small, and the tibiae and tarsi are strongly bespined. The middle tibia ends in a single spur. The anterior tarsi are provided with tarsal combs on the outer (posterior) side; these are strongly developed on the female, much less so on the male. The claws are always simple, never toothed, and the pulvilli are always developed.

The males of the different species show a variety of secondary sexual characters, appearing on the antennae, legs, and sternites. Various segments of the antennae are pitted, dilated, curved, or spinose; the middle femora are sometimes serrate or dentate; the middle metatarsus may be curved and the second or sixth sternite (or both) may bear a process or a carina of some kind. All these characters are available for the determination of species.

The general color of the body is black. The color of the maculations varies from white or yellowish white to rich orange yellow. In some species the extensive development of the maculations almost suppresses the black ground color. On the species of this genus, especially on the males, the pubescence is on the whole better developed than on those of closely related genera.

In the determination of species in this genus we take into consideration (1) the relative direction of the inner borders of the compound eyes, (2) the width of the frons in comparison with the width of the compound eye at a given level, (3) the relative length of the segments of the antennae, (4) the secondary sexual modifications of the segments of the flagellum of males, (5) the development of the mandibles, (6) the development of the labrum, (7) the character of the middle femora of the males, (8) the form of the ultimate tergite, (9) the character of the processes on sternites 2 and 6 of the male, (10) the character of the seventh sternite of the male, (11) the form of the male genital armature, and (12) the character of the maculations, size, and habitat.

KEY TO SPECIES.

Males.

1. Intermediate femora distinctly serrate or dentate.....2.
1. Intermediate femora smooth; not distinctly serrate or dentate.....16.
2. Second and sixth sternites without processes, plain.....3.
2. Second and sixth sternites with more or less well developed processes.....6.
3. First segment of middle tarsus distinctly curved, its inner surface beset with several stout spines.....4.
3. First segment of middle tarsus not so formed, development normal.....5.
4. Mesosternum marked with black; sternites 2-4 for the most part black; genital stipes as in fig. 140.....*arcuata*.
4. Mesosternum yellow; sternites 2-4 almost entirely yellow; stipes as in fig. 141.
U-scripta.
5. Clypeus with lateral borders black; tarsi more or less heavily suffused with black above.....*cinerea*.
5. Clypeus wholly yellow; tarsi entirely yellow.....*hinei*.
6. Process on sixth sternite prominent, its ventral surface flattened and bifurcate at apex; genital stipes as in figs. 149, 151.....7.
6. Process on sixth sternite a transverse ridge not sharply pointed but slightly curved on either side the midline.....8.
6. Process of sixth sternite prominent, flattened and bluntly pointed; an additional pair of small processes or ridges on this same sternite.....*nubilipennis*.
6. Process on sixth sternite not as above; relatively small, acutely pointed or if flattened the sixth sternite lacks the lateral processes or ridges.....9.
7. Spur on the middle tibia reaching to or beyond the middle point of the metatarsus.
amoena.
7. Spur on the middle tibia not reaching to or beyond the middle point of the metatarsus.....*sayi*.
8. Fasciae on tergites interrupted; labrum with transverse impression; seventh sternite not conspicuously narrowed.....*belfragei*.

8. Fasciae on tergites continuous; labrum without transverse impression; seventh sternite conspicuously narrowed.....*stenebdoma*.
9. Fasciae on second tergite inclosing a pair of black spots; lateral spots on sternites may be connected by apical lines.....10.
9. Fascia on second tergite not inclosing black spots; lateral spots on sternites not connected by apical lines.....11.
10. Dorsum of median segment not maculated; genital stipes as in fig. 156.....*fozi*.
10. Dorsum of median segment bearing lateral spots; genital stipes not as in fig. 156.
connexa.
11. Sides of median segment and of thorax (excluding prothorax) black, or rarely with small spot on mesopleura.....12.
11. Sides of median segment and of thorax conspicuously maculated.....15.
12. Fasciae on tergites narrow, usually (but not always) all interrupted; ultimate tergite black.....*spinolae*.
12. Fasciae on tergites broader, all except the first continuous; ultimate tergite maculated.....13.
13. Fifth flagellar segment spinose; pubescence normal; process on sixth sternite short, broad, and roundly pointed; fasciae on tergites bright yellow...*cameroni*.
13. Fifth flagellar segment not spinose; pubescence unusually well developed; process on sixth sternite narrow and sharply pointed; fasciae on tergites white or greenish yellow.....14.
14. Fasciae on tergites white.....*comata*.
14. Fasciae on tergites greenish yellow.....*primaestate*.
15. Scutellum with a pair of lateral spots.....*similans*.
15. Scutellum without lateral spots.....*primaestate*.
16. Second and sixth sternites without processes.....*pruinosa*.
16. Second sternite with a longitudinal carina; sixth with two small approximate tubercles; seventh terminating in a spine.....17.
16. Process on sixth sternite simple, median, pointed; that on second more or less well developed, in exceptional cases lacking.....18.
17. Sides of thorax and median segment black; yellow on tergites limited to lateral spots.....*beutenmulleri*.
17. Sides of thorax and median segment almost entirely yellow; tergites with continuous broad yellow fasciae.....*occidentalis*.
18. Scutum usually with a pair of more or less well developed discal marks; dorsum of median segment with a curved yellow fascia.....*trogodytes*.
18. Scutum without discal spots; dorsum of median segment black.....19.
19. Postscutellum with a narrow whitish fascia; second sternite with a broad yellow fascia embracing the posterior part of the median process and may include a pair of black spots.....*melanaspis*.
19. Postscutellum immaculate; second sternite with triangular lateral spots that may be connected by narrow apical band.....20.
20. Markings of abdomen and sides of thorax white or creamy white; species somewhat robust.....*texana*.
20. Markings of abdomen and sides of thorax bright lemon yellow; species slender.
helianthopolis.

Females.

1. Neither postscutellum nor dorsum of median segment (excluding postero-lateral angles) marked with yellow.....2.
1. Postscutellum or dorsum of median segment or both marked with yellow.....15.
2. Fasciae on tergites all interrupted medially.....3.
2. A part or all of the fasciae on tergites continuous.....9.
3. Ultimate tergite strongly wrinkled.....*belfragei*.
3. Ultimate tergite not wrinkled, punctate.....4.

4. Pubescence on head and thorax, especially on the sides, unusually long and hoary; spur on middle tibia reaching to or beyond the middle point of the metatarsus.....*amoena*.
4. Pubescence not unusually long; spur on middle tibia not reaching middle point of metatarsus.....5.
5. Fasciae on tergites sinuate but not greatly attenuated medially; body rather slender.....6.
5. Fasciae on tergites wide laterally and much attenuated medially or reduced to widely separated lateral spots; body relatively robust.....7.
6. Fascia on second tergite imperfectly inclosing a pair of dorsal black spots, those on third and fourth with pair of anterior emarginations; fasciae yellow....*foxi*.
6. Fascia on second tergite sinuate like those on third and fourth; fasciae white.
spinolae.
7. Eyes not widely separated and plainly divergent at the clypeus; lateral spots on sternites connected by narrow apical lines.....*beutenmulleri*.
7. Eyes widely separated and not divergent at the clypeus; lateral spots on sternites not connected.....8.
8. Abdominal markings creamy white; tibiae heavily marked with black; length about 16 mm.....*cinerea*.
8. Abdominal markings yellow; tibiae yellow; length 18-20 mm.....*hinei*.
9. Clypeus with a more or less conspicuous pair of basal black spots; fasciae on tergites white, second usually inclosing a pair of black spots.....*tezana*.
9. Clypeus not marked basally with black spots.....10.
10. Sides of thorax and median segment with evident maculations.....11.
10. Sides of thorax and median segment black, rarely with inconspicuous maculation on mesothorax.....13.
11. Form large and robust, 17-20 mm; fascia on second tergite inclosing more or less perfectly a pair of dorsal black spots.....*connexa*.
11. Form more slender, 14 mm; fascia on second tergite not inclosing black spots..12.
12. Fasciae on tergites yellow.....*similans*.
12. Fasciae on tergites white.....*primaestata*.
13. Fasciae on tergites bright yellow; ultimate tergite with central yellow maculation.....*cameroni*.
13. Fasciae on tergites soiled or greenish white or rarely greenish yellow; ultimate tergite black or with white maculation.....14.
14. Pubescence normal; ultimate tergite black.....*spinolae*.
14. Pubescence unusually conspicuous; ultimate tergite with white maculation, which in some cases is much obscured.....*comata*.
15. Wings distinctly clouded medially.....16.
15. Wings clear.....17.
16. Clypeus black or marked with black basally; lateral spots on sternites united by apical lines.....*melanaspis*.
16. Clypeus yellow; lateral spots on sternites not connected (except rarely on second sternite).....*nubilispennis*.
17. Scutum with no trace of discal marks.....18.
17. Scutum with more or less well developed discal marks.....22.
18. Large, 17-20 mm; eyes divergent at clypeus; frons narrow; fasciae on tergites continuous.....19.
18. Smaller, 14-16 mm; eyes very slightly divergent at vertex; frons relatively wide; fascia on first tergite almost always interrupted.....20.
19. Fasciae on tergites white; that on second never inclosing black spots; clypeus usually with basal black mark.....*pruinosa*.
19. Fasciae on tergites yellow; that on second always inclosing pair of black spots; clypeus yellow.....*occidentalis*.

20. Fasciae on tergites yellow.....21.
 20. Fasciae on tergites white.....*primaestate*.
 21. Clypeus yellow.....*similans*.
 21. Clypeus black.....*helianthopolis*.
 22. First transverse cubital vein but slightly bent; development of ocelli unusual..23.
 22. First transverse cubital vein normal; ocellar cicatrices normal.....24.
 23. Lateral spots on sternites 2-5 and apex of six yellow.....*U-scripta*.
 23. Yellow on tergites limited to lateral spots on 2-4.....*arcuata*.
 24. Frons narrow; eyes divergent at the clypeus; mandibles slender, nearly devoid of teeth.....*occidentalis*.
 24. Frons normal; eyes not divergent at the clypeus; mandibles normal.....25.
 25. Labrum unusually long (see fig. 217); ultimate tergite rugose (see fig. 216)..*rugosa*.
 25. Labrum normal; ultimate tergite not rugose, punctate.....26.
 26. Clypeus black or marked with black basally.....27.
 26. Clypeus yellow or pale.....28.
 27. Labrum yellow; ultimate tergite marked with yellow.....*troglydites*.
 27. Labrum black; ultimate tergite black.....*helianthopolis*.
 28. Species large, 17-20 mm.; discal marks on scutum in form of a U, complete or broken into spots.....29.
 28. Species smaller, under 17 mm.; discal marks on scutum consisting of a pair of narrow lines.....30.
 29. Second and third sternites broadly banded with yellow; second flagellar segment not equal to the combined length of the third and fourth.....*latifrons*.
 29. Second and third sternites with only lateral spots; second flagellar segment equal to or greater than the combined length of the third and fourth.....*sayi*.
 30. Fasciae on tergites yellow.....*similans*.
 30. Fasciae on tergites white.....*primaestate*.

BEMBIX ARCUATA, new species.

Figs. 139, 140, 185, 206, 207.

Male.—Black: Labrum, mandibles except apices, clypeus, scape below, frons except a butterfly-shaped spot below anterior ocellus, posterior orbits prolonged above but not meeting on vertex, prothorax, lateral lines, and narrow longitudinal discal lines on scutum, broad fascia on scutellum, fascia on metanotum, curved fascia on dorsum of median segment extending down on posterior surface, lateral angles and sides of same, metapleurae almost completely, spot on posterior part of mesopleurae, anterior part of mesosternum, fasciae on tergites 1-5, first narrowly interrupted medially, the anterior border emarginate on either side the midline, second and third narrowed and interrupted medially, biemarginate on anterior dorsal border and on posterior border curved forward on either side toward the midline, fourth similar in design to the third, fifth continuous and biemarginate on anterior border, median spot on sixth, apex of seventh, greater part of the first sternite, lateral spots on 2-4, greater part of coxae and trochanters, femora except stripe on posterior surface, tibiae, and tarsi, *yellow*.

The scape is short, broad, and unusually hirsute, and segments 6-11 of the flagellum are slightly spinose on the posterior side. As

in the following species this character is in great part produced by the apical borders of the segments on the posterior surface. The ultimate segment is curved, flattened dorso-ventrally, pointed at the apex, and in length somewhat less than the combined length of the two segments immediately preceding. The middle femora below are beset with numerous short spinelike teeth and the middle tibiae, slightly carinate on the inner surface, have the apical margin on the anterior side drawn out into a process bearing a short spine at its tip. The middle metatarsi are curved on the inner side and bear near the base four spines. The second and sixth sternites are devoid of processes, the seventh bears a pair of carinae that diverge basally, and the eighth ends in a single spine. The genital stipes is very strikingly different from that of *U-scripta* Fox.

The maculations on the paratypes vary somewhat from those of the type specimen. Some specimens show a more or less well developed, but broken, U-shaped discal mark on the scutum, the curved fascia on the median segment may be broad and conspicuous or narrow and broken; the spots on the sides of the thorax vary in extent; the first tergal fascia may be continuous, and the fifth may be broken into spots.

Female.—Black: Labrum, mandibles except apices, clypeus except median pair of black spots, scape and flagellum below, frons except butterfly-shaped spot below anterior ocellus, posterior orbits not prolonged on vertex, prothorax, lateral lines and broken U-shaped discal mark on scutum, fascia on scutellum, fascia on metanotum, broken curved fascia on dorsum of median segment, lateral angles and sides of same, metapleurae and mesopleurae almost entirely, anterior border of mesosternum, fasciae on tergites 1-4, all continuous except the third and similar in design to those of the male, three spots on the fifth, apex of the sixth, lateral spots on sternites 2-4, spot on anterior coxae, trochanters distally, femora except a broad stripe above and a short one also below on posterior pair, tibiae, and tarsi, *yellow*. The ultimate tergite is somewhat wrinkled and is bordered apically by short but well marked lateral ridges.

Length.—17-19 mm.

The scape is short but not so broad as in the male. The flagellum is tawny yellow below in the female but in the male it is more testaceous. The wings are hyaline, the veins dark brown. The first transverso-cubital vein is only slightly curved. The pubescence is tolerably long and dense and is yellowish white in color; on the abdomen it is quite short. The ocelli and the labrum are similar to those of the following species to which this species is very closely related.

This species is described from four males in the United States National Museum, three of which were collected in Texas and one in New Mexico, and from one female in the collection of the Uni-

versity of Kansas. The male can be distinguished from the male of *U-scripta* Fox, by the character of the genital stipes as shown in the figures and by the fact that *U-scripta* has the mesosternum and the second and third ventral abdominal segments completely yellow and yellow fasciae on the fifth and sixth. The mesosternum of *arcuata* is marked with black, sternites two and three have only lateral spots and five and six are entirely black. The female of *U-scripta* has the mesosternum wholly yellow, lateral spots on sternites 2-5, and the apex of six marked with yellow; the female of *arcuata* has the mesosternum marked with black and the yellow on the sternites confined to small lateral spots on 2-4.

Habitat.—Texas, New Mexico, Kansas.

Type.—Cat. No. 19807, U.S.N.M.

BEMBIX U-SCRIPTA Fox.

Figs. 141, 208.

Bembex U-scripta Fox, Proc. Acad. Nat. Sci. Phila., 1895, p. 362, pl. 14, figs. 5, 9, female, male.

Male.—Black: Labrum, mandibles except apices, clypeus, scape, flagellum below, frons except pair of triangular black spots below anterior ocellus, and pair of widely separated points at base of clypeus, broad posterior orbits united across vertex, prothorax entirely, tegulae, broad lateral lines and broad U-shaped discal mark on scutum, broad fascia on scutellum, fascia on metanotum, dorsum and posterior surface of median segment except black band adjacent to postscutellum and narrow border of oblique sutures, sides of median segment, metapleurae and mesopleurae entirely, mesosternum, broad fasciae on tergites 1-5, each with a pair of emarginations and a medial notch on anterior border, the emarginations on second and third deepest, three spots on sixth tergite, apex of seventh, sternites 1-3 almost entirely, broad fascia on fourth with medial emargination on anterior border, narrow broken fascia on fifth, broader one on sixth, apex of seventh, legs except narrow stripes on posterior surface of anterior and posterior femora, yellow.

The scape is very short and broad and segments 5-11 of the flagellum are slightly spinose on the posterior surface, 8-11 most evidently so. The apical segment is curved, conical in outline and almost as long as the two segments immediately preceding it. The middle femora are dentate. The middle tibiae are slightly carinate on the inner surface and the anterior margin at the apex is drawn out into a process that bears a short spine at its tip. The middle metatarsi are strongly curved on the inner side and basally bear four spines. The second and sixth sternites are without processes of any kind, but the seventh bears a pair of carinae that diverge basally. The eighth ends in a single spine.

Female.—Black: Labrum, mandibles except apices, clypeus except a pair of medial spots that may merge into one, scape and flagellum below, frons except a butterfly-shaped spot below anterior ocellus, broad posterior orbits united across vertex, prothorax, broad lateral lines, and U-shaped discal mark on scutum, fascia on scutellum, metanotum, dorsum and posterior surface of median segment except black transverse border adjacent to postscutellum and border of oblique sutures, sides of median segment, metathorax and mesothorax, mesosternum entire on greater part, broad continuous fasciae on tergites 1-4, each with a medial notch and a pair of dorsal emarginations on anterior border, second, third, and fourth with less prominent lateral emarginations, three spots on fifth, apex of sixth, first sternite, second except a rather broad, medial, longitudinal black mark, lateral spots on 3-5, apex of sixth, legs except stripe on posterior surface of femora, and sometimes on tibiae below, *yellow*. The sixth tergite is somewhat wrinkled and apically there is a pair of short but well marked lateral ridges.

Length.—18 mm.

The scape in the female is short but not so broad as in the male. The ocelli in this and the preceding species are peculiar in that the posterior pair are well developed, though not perfectly round, and are in all probability functional. The anterior ocellus is also developed, appearing in long oval form but to what extent it is functional, if any, is yet to be learned. All three ocelli are light or amber in color on the dried insects. At the base the labrum bears a triangular flattened median area the apex of which forms a slight prominence on the median line. When viewed from the side a slight transverse depression is evident just distal to this prominence from which to the apex along the midline extends a slight carina. The wings are hyaline, the veins dark brown, and the first transverso-cubital vein is but slightly curved. The pubescence on the head and thorax is long, tolerably dense and yellowish white; that on the abdomen is quite short. The extent of the color on the thorax is unusually variable. On one specimen, from Arizona, the thorax is entirely yellow except for the narrow longitudinal lines on the scutum.

Habitat.—Arizona, California, and New Mexico.

Number of specimens examined—Males, 2; females, 4.

BEMBIX CINEREA Handlirsch.

Figs. 142, 143, 186.

Bembex cinerea HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 102, 1893, p. 837, pl. 2, fig. 34; pl. 3, fig. 29, female, male.

Male.—Black: Labrum, except the lateral borders, sometimes small spots on mandibles, clypeus except the more or less wide lateral borders, small spot between antennae, scape below, abbreviated

anterior orbits, which may be lacking, narrow posterior orbits, which also may be lacking, lateral spots on tergites 1-4 or 1-5, lateral spots on sternites 2-4 or 2-5, femora distally below more or less, tibiae below and on anterior border, tarsi in varying degree, *yellow*.

The flagellum is cylindrical; segments 7 and 8 are very faintly spinose on posterior border, due to the presence of specialized areas, which on these and on the more apical segments do not assume the form of prominent pits. The apical segment is not curved, is rounded at the apex and is somewhat shorter than the combined length of the two just preceding it. The middle femora are finely serrate below. The middle tarsus is relatively shorter than is usual for the species of this genus, but on all specimens before me it is somewhat longer than its subtending tibia. The second and sixth sternites are usually without processes of any kind, but occasionally a very small one is found on the sixth. The seventh bears a median carina and also a pair of less prominent lateral carinae.

Female.—Black: Labrum, clypeus, scape below, spot between antennae, abbreviated anterior orbits, much reduced posterior orbits, femora distally below more or less, tibiae on anterior borders, tarsi in varying degree, *yellow*. Lateral spots on tergites 2-4 or 2-5, in some specimens broad at the sides but attenuated toward the midline, where they are more or less approximated, lateral spots on sternites 2-4 or 2-5, *yellowish or greenish white*.

Length.—13-17 mm.

The eyes in this species are widely separated, slightly more so in the female than in the male, and their inner margins are almost parallel. The head, thorax, and base of abdomen are covered with rather long white pubescence; elsewhere on the abdomen the pubescence is shorter. The ultimate tergite of the female is evenly and coarsely punctate, giving its surface a roughened appearance; laterally it is provided with long white pubescence among which are placed some short black spines. The extent and the intensity of the black marks upon the tarsi vary much, but on both sexes the hind tarsi are constantly very dark, almost black above. In his description of this species Handlirsch fails to state the color of the maculations.

The male of this species is distinguished by the presence of the black borders on the clypeus, which leave the central yellow spot in the form of a triangle with the apex at the midline of the base of the clypeus. It is further distinguished from the following species by its smaller size and by the presence of the black color of the tibiae, a mark that also distinguishes the female of this species from that of the following.

Habitat.—Georgia, Florida, Texas, and New Jersey.

Number of specimens examined—Males, 13; females, 5.

BEMBIX HINEI, new species.

Figs. 144, 145, 187, 209.

Male.—Black: Labrum, clypeus, mandibles except apices, spot between antennae, scape below, broad anterior orbits much shortened above, narrow posterior orbits, spot on sides of prothorax including lower part of tubercles, tegulae in part, spot on base of anterior wing, conspicuous lateral spots on tergites 1–5, lateral spots on sternites 2–6, greater part of femora, tibiae, and tarsi entirely, *yellow*. The flagellum is neither spinose nor dentate, the middle femora are feebly serrate, and the middle tarsi are short as in the case of *cinerea*. The second and sixth sternites are without processes. The seventh bears a median carina and a lesser pair of lateral carinae.

Female.—Black: Labrum, clypeus, mandibles except apices, spot between antennae, scape below, broad anterior orbits, narrow posterior orbits, spot on sides of prothorax including part of tubercles, tegulae in part, spot on base of anterior wing, conspicuous lateral spots on tergites 1–5, those on first segment widely separated, those on 2–4 attenuated toward mid-dorsal line and more or less approximated, lateral spots on sternites 2–5, greater part of the femora, tibiae, and tarsi entirely, *yellow*.

Length.—15–19 mm.

The wings in both sexes are hyaline and the pubescence is white, tolerably dense, and short except on the frons. It is very short on the abdomen except on the sixth tergite of the female, where it is white, long, and mingled with short, stout black spines. The variation in the maculations is slight and insignificant.

This species stands quite close to *B. cinerea* Handlirsch, to which species most of the individuals of this one found in our collections have been referred by those who identified them. A few specimens have been confused with *B. beutenmulleri* Fox, from which species the female of this one can with difficulty be distinguished. It differs from *cinerea* both in size and coloration. These differences, although they are the least satisfactory to depend upon in determining species, are clear cut in both males and females, and I have found no intermediate forms. In *cinerea* the abdominal markings on the female are creamy white, in *hinei* they are deep yellow; in *cinerea* the clypeus is bordered with black in the male, in *hinei* the clypeus is invariably yellow. In *cinerea* in both sexes the mandibles are black and the tibiae and tarsi are more or less black; in *hinei* these parts are almost wholly yellow, the tarsi invariably so. The genital stipes also differs in form from that of *cinerea*.

Named for my friend and first instructor in entomology, Prof. James S. Hine.

Habitat.—Texas, and Louisiana.

Number of specimens examined—Males, 10; females, 21.

Type.—Cat. No. 19809, U.S.N.M.

BEMBEX NUBILIPENNIS Cresson.

Figs. 146, 147, 188.

Bembex nubilipennis CRESSON, Trans. Amer. Ent. Soc., vol. 4, 1872, p. 218, female, male.

Bembex nubilipennis HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 102, 1893, p. 838, pl. 2, fig. 38; pl. 7, fig. 25.

Male.—Black: Labrum, mandibles except apices, clypeus, lower part of frons, spot before anterior ocellus, scape below, broad anterior orbits, posterior orbits, narrow line on posterior border of pronotum, sometimes widely interrupted medially or entirely wanting, spot on sides of prothorax variable in extent and usually including the tubercles, spot on tegulae, short lateral lines on scutum above base of wings, sometimes small lateral spots on scutellum, spot on lateral angles of median segment very frequently lacking, small spot on mesopleurae on a few specimens, broad fasciae on tergites 2-5 and sometimes 6, the first abruptly narrowed and more or less widely interrupted medially, the remaining fasciae with rare exceptions all continuous, biemarginate, and slightly notched medially, on anterior border and more widely notched medially on posterior border, lateral spots on sternites 2-5, which may or may not be connected by apical lines, femora except basally, tibiae, and tarsi, *yellow*.

Segments 6-9 of the flagellum are spinose on the posterior border and segments 4-11 on the posterior surface bear pits, those on 10 and 11 being large and conspicuous. The ultimate segment is a trifle longer than the preceding segment, only slightly curved, broader at the base than at the apex, and is roundly truncate apically. The intermediate femora are unevenly and raggedly serrate below. The second sternite bears a large median tubercle, hooked and pointed posteriorly, and the sixth bears a prominent oblique process, flattened on its distal surface and roundly pointed at the apex. This sternite also bears an additional pair of rounded lateral processes or ridges.

Female.—Black: Labrum, mandibles except apices, clypeus, scape below, space between insertions of antennae extended upward slightly, spot in front of anterior ocellus, broad anterior orbits, broad posterior orbits narrowed above, posterior border of pronotum, sides of prothorax except dusky line in front of tubercles, tegulae, lateral lines on scutum frequently shortened, sometimes a pair of discal lines on scutum, broad fascia on scutellum sometimes narrowed medially, fascia on metanotum, curved fascia on dorsum of median segment frequently interrupted medially, lateral angles of median segment and more or less of sides of same, spot on metapleurae, spot variable in size on mesopleurae, broad continuous fasciae on tergites 1-5, the first sometimes interrupted medially, more frequently roundly emarginate on anterior middle, rarely inclosing a pair of small medial anterior black spots, second usually inclosing a pair of black spots

which may appear as anterior emarginations, third, fourth, and fifth more or less distinctly biemarginate on anterior border, second, third, and fourth acutely notched at middle of posterior border, lateral spots on sternites 2-5, those on second sometimes connected by an apical line, femora except to a slight extent basally, tibiae, and tarsi, yellow.

Length.—17-20 mm.

The wings of the female are conspicuously clouded medially; those of the male are hyaline with only a trace of the clouding on the wings of some individuals. The veins are dark brown. The flagellum on the female is usually fulvous or tawny below, but on the male the color is limited to the more basal segments. The pubescence is light, sparse and relatively short. The variation in the maculations of this species is greater than usual, especially on the female. The great majority of the females do not show discal marks on the scutum but a few specimens show not only a well developed pair of longitudinal discal lines but also a posterior transverse line. On some the sides of the thorax and median segment are almost wholly yellow, whereas on others these parts are almost entirely black.

Habitat.—Tennessee, Iowa, Illinois, Kansas, Texas, New Mexico, Colorado, and Arizona.

Number of specimens examined—Males, 31; females, 46.

BEMBIX AMOENA Handlirsch.

Figs. 148, 149, 189, 210.

Bembex amoena HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 102, 1893, p. 769, male, female, pl. 1, fig. 32; pl. 6, fig. 31.

Male.—Black: Labrum, mandibles except apices, clypeus, lower part of frons, scape below, broad anterior orbits sometimes shortened above, narrow posterior orbits broader below and not reaching vertex above, spot on sides of prothorax sometimes including tubercles, spot on tegulae, wanting in some specimens, large irregular spot on side of mesopleurae united on mesosternum, pair of small spots on mesosternum in front of middle coxae, sometimes wanting, fasciae on tergites entirely absent or present on 1-5, first broad laterally, narrow and widely interrupted medially, remainder narrow, strongly undulate and narrowly interrupted medially, pair of median spots on sixth, lateral spots on sternites 1-5, sometimes reduced to 2-3, coxae below more or less, trochanters more or less in some specimens and in others not at all, femora below, tibiae except spot below in some specimens, and tarsi, *greenish yellow or white*.

Segments 5-8 of the flagellum when viewed from above show small but distinct spines on the posterior surface, and segments 5-12 bear pits or excavations on their posterior surfaces best developed on

9-11. The apical segment is only slightly curved and when seen from above is of uniform width from base to near the apex, which is slightly rounded. The middle femora are distinctly dentate below and the middle tibiae bear on their inner surface a distinct, but not greatly compressed carina. The apical spur of the middle tibia reaches to or beyond the middle point of the metatarsus. The second sternite bears a median longitudinal process and the sixth a prominent, elongated process that is flattened on its ventral surface in a plane nearly parallel with the long axis of the body and is usually bifurcate at the tip. The seventh bears a median prominent carina and laterally near the base a pair of slight elevations.

Female.—Black: Labrum, mandibles except apices, clypeus, lower part of frons, anterior orbits, scape below, posterior orbits broader below, broken spot on sides of prothorax, one or two small spots on mesopleurae, fasciae on tergites 1-4 or 1-5, first narrowed medially and rather widely interrupted, remainder strongly undulate and narrowly interrupted medially, that on 5 sometimes broken or suppressed, lateral spots on tergites 2-4 or 2-5, spot on anterior coxae below, absent on some specimens, femora below more or less, tibiae except broad stripe below, and tarsi, *greenish white or greenish yellow*, the tibiae and tarsi having a rusty tinge. The sixth tergite is coarsely and irregularly punctated with a tendency to become rugose at the sides apically.

Length.—19-22 mm.

The wings in both sexes are hyaline, veins brown. The head, thorax, median segment and base of abdomen are covered with long, dense pubescence, particularly well developed about the head, on the median segment and base of abdomen. The pubescence on the basal segments of the legs, dorsal surface of the thorax and the abdomen, except the base, is shorter and less conspicuous. The scape is heavy and stout, especially on the male. The flagellum is much lighter below than above on the female, less evidently so on the male. The apical spur on the middle tibia of the female is the same as on the male.

The extremes of the series show a wide variation in the color markings. This is especially true for the male. At one extreme the abdomen is entirely black; at the other, tergites 1-5 each bears a comparatively broad fascia interrupted medially, and the sixth a pair of median spots. With reference to other maculations the extremes show a like divergence. At one extreme we find the sides of the thorax and median segment showing only a small spot on the mesopleurae; at the other not only the thorax but even the sides of the median segment show prominent maculations. Between these extremes, however, we find a well-graded series passing from one to the other. In the female the divergence, though evident in the series, is not so great.

On some specimens a pair of irregular black basal spots is found on the clypeus which spots are lacking on those on which the yellow maculations are best developed.

It is difficult to distinguish the most highly colored males of this species from the least well maculated males of *sayi*. The characters that distinguish this species from the latter are, however, the long apical spur of the middle tibia and the shape of the process on the sixth sternite. The genital stipes of the two are almost identical.

Habitat.—Yellowstone Park, Utah, Idaho, Wyoming, and California.

Number of specimens examined—Males, 17; females, 5.

BEMBIX SAYI Cresson.

Figs. 150, 151, 190, 211.

Bembex sayi CRESSON, Proc. Ent. Soc. Phila., vol. 4, 1865, p. 467, female.

Bembex sayi HANDLIRSCH, Sitz. Acad. Wissensch. Wien, Math.-Nat. Cl., vol. 102, 1893, p. 877, female.

Male.—Black: Labrum, mandibles except apices, clypeus, lower part of frons continued upward between the antennae and united with spot in front of anterior ocellus, broad anterior orbits, scape except narrow stripe above, posterior orbits, prothorax entirely, tegulae, lateral lines and a pair of narrow discal lines on scutum, narrow fascia on posterior border of scutellum greatly enlarged laterally, narrow fasciae on metanotum, large triangular spot squarely emarginate below on posterior surface of median segment, lateral angles and sides of same, metapleurae, one large irregular spot continued on mesosternum and two small posterior ones on mesopleurae, broad fasciae on tergites 1–6, all undulate laterally and continuous except the first, second inclosing a pair of elliptical dorsal black spots, third, fourth, and fifth biemarginate on anterior dorsal border, second to sixth distinctly notched medially on posterior border, posterior border of first sternite, large lateral spots on second almost united medially, smaller lateral spots on 3–6, legs entirely except black stripe above on anterior femora, small black spots on base of trochanters and at base of posterior femora, *yellow or yellowish white*.

The description above is made from the most highly colored male in the series before me. The least highly colored is as follows: Labrum, mandibles except apices, clypeus, lower part of frons, scape below, anterior and posterior orbits, small lateral spots on dorsal border of pronotum, large spot on sides of prothorax including tubercles in part, spot on tegulae, minute spot above tegulae on scutum, two spots on mesopleurae, pair of smaller ones on mesosternum, narrow undulate, interrupted fasciae on tergites 1–5, small lateral spots on sternites 2 and 3, spot on anterior and middle coxae below,

femora except broad stripe above on all and a short one below on posterior pair, tibiae except narrow line below on anterior and middle pairs, and tarsi, *yellow or yellowish white*. The markings of the abdomen are decidedly white.

Between these two extremes I have before me a very complete series of gradations wherein the extensive markings of the one are almost imperceptibly reduced to the meager maculations of the other. In other respects the series is remarkably uniform. The scape is broad and stout and viewed from the side is larger apically than at the base. Segments 5–8 of the flagellum are spinose posteriorly and 4–12 bear pits or excavations on their posterior surface, most conspicuous on 9–11. The apical segment seen from above is curved and widest at the base, the width decreasing perceptibly toward the apex. The middle femora are dentate below and the middle tibiae bear a longitudinal carina on the inner side. The spur at the apex of the middle tibia is less than half the length of the middle metatarsus. The second sternite bears a prominent, laterally compressed, median process, and the sixth a process equally prominent, usually bifurcate at the apex, its ventral surface flattened or provided with a median groove but not placed parallel with the long axis of the body as in the case of *amoena*.

Female.—Black: Labrum, mandibles except apices, clypeus, lower part of frons, spot before anterior ocellus, broad anterior orbits, posterior orbits broad below, prothorax except dusky spot in front of tubercles and an anterior dorsal median spot sometimes broken into lateral spots, tegulae, lateral lines on scutum, pair of longitudinal discal lines and a posterior transverse discal line, sometimes wanting, on scutum, transverse fascia on posterior border of scutellum enlarged laterally, fascia on metanotum rarely wanting, curved fascia on dorsum of median segment, its lateral angles and sides except a median black emargination on dorsal border of side, metapleurae, mesopleurae wholly or for the most part, broad fasciae on tergites, all continuous except the first, which is narrowly interrupted medially, the second or second and third inclosing a pair of dorsal elliptical black spots, which in some specimens are united with the anterior black border in the form of emarginations, fourth and fifth with a pair of anterior dorsal emarginations and a less evident pair of lateral ones, second to fifth with a deep acute median notch on posterior border, spot on apex of ultimate tergite, reduced in some specimens and wanting in others, lateral spots on sternites 1–5 or 2–4, legs almost entirely in the lighter specimens, in the darker ones spots on anterior and middle coxae, femora except above and stripe below on posterior pair, tibiae except stripe below on all, and tarsi, *yellow or yellowish white*.

Length.—17–19 mm.

On both sexes the pubescence on the head, thorax, median segments and base of abdomen is white and moderately long and dense, but not so well developed as in the case of *amoena*. The wings are hyaline, veins brown. The scape is relatively short and heavy; the flagellum is reddish below, especially in the female. The punctures of the scutum are moderately large, evenly but not closely distributed. Those of the median segment smaller and more closely placed. The punctures of the ultimate tergite are coarser, variable in size, and more irregularly placed. A small female from Texas apparently belongs in this species, though it lacks the discal marks on the scutum, the yellow fascia on the median segment and the dorsal fasciae are narrow and none inclose paired black spots.

Habitat.—Florida, Texas, New Mexico, Colorado, Kansas, South Dakota, and Wyoming.

Number of specimens examined—Males, 29; females, 15.

BEMBIX BELFRAGEI Cresson.

Figs. 152, 153, 191, 212, 213.

Bembex belfragei CRESSON, Trans. Amer. Ent. Soc., vol. 4, 1873, p. 220, male.

Bembex cressonis HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 102, 1893, p. 792, male, female, pl. 5, fig. 6.

Bembex insignis HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 102, 1893, p. 793, male, female, pl. 2, fig. 7; pl. 6, fig. 32.

Bembex belfragei FOX, Proc. Acad. Nat. Sci., Phila., 1895, p. 357.

Male.—Black: Labrum wholly or with small basal spots or not at all, clypeus, wholly or with pair of apical spots or not at all, mandibles except apices, scape below or not at all, anterior orbits and spot between antennae which marks may all be lacking, posterior orbits, spot on sides of prothorax continued on tubercles or wholly wanting, rarely spot on mesopleurae and small lateral spots on scutellum, fasciae on tergites 1-4 or 1-6 all interrupted medially, first broad and more widely interrupted than the remainder, second and third broad laterally and abruptly narrowed dorsally on either side the midline, remainder narrower and somewhat undulate, lateral spots on sternites 2-3 or 2-5, femora below more or less, tibiae except much of lower surface, and tarsi, *yellow or greenish yellow*.

Segments 7-9 of the flagellum are slightly produced on their posterior margin and 9-11 bear prominent pits. The apical segment is slightly curved and is longer but narrower than the segment preceding it. The middle femora are dentate below on the distal half. The second sternite bears a large medial, laterally compressed, slightly hooked process. The sixth bears a heavy prominent transverse ridge usually drawn to a sharp edge on its posterior distal border, bluntly pointed medially and slightly curved on either side. The seventh bears a small median posterior process from which a pair of inconspicuous carinae diverge basally. The apical surface of the ultimate tergite is more or less rugose.

Female.—Black: Spot on mandibles not always present, very small lateral spots on scutellum, fasciae on tergites 1-4 interrupted medially, the first broad and a trifle more widely interrupted than the others, second and third broad laterally and on anterior border abruptly narrowed or emarginated on either side the midline, fourth narrower but similar in design to the third, small posterior lateral spots on sternites 2 or 2-4, only the border of the femora, tibiae, and tarsi more or less, or distal ends of the femora and the tibiae and tarsi almost entirely, *yellow or greenish yellow*. The dorsal surface of the ultimate tergite is strongly wrinkled longitudinally.

Length.—16-18 mm.

The females from Wisconsin have the antennae and the front of the head, except spot on mandibles, entirely black. In both specimens there are yellow spots on the mesopleurae, lateral spots on the scutellum, also on metanotum and median segment dorsally, and on sternites 2-3. On one the spots are better developed than on the other, the first and second tergal fasciae are very broad, the second dorsally enclosing a pair of black spots, a character peculiar to Handlirsch's *insignis*. The females from Kansas have the antennae, the head, except the much-reduced posterior orbits, and the thorax, except small lateral spots on scutellum, wholly black. The legs also, including the tibiae and tarsi, are almost entirely black, and the yellow on the venter of the abdomen is reduced to small lateral spots on sternites 2 or 2-3. The characteristic wrinkling of the sixth tergite is constant on all the specimens.

In both sexes the labrum when viewed from the side shows a distinct transverse impression. The scape is short and stout; the flagellum is black and the apical segment is longer but slightly narrower than the preceding segment. The wings are very slightly infumated, the veins brown. The head, thorax, median segment and base of abdomen are covered with relatively short, moderately dense pubescence, dark on dorsum of thorax, white elsewhere. The punctuation of the dorsum of the thorax is regular, close, and moderately fine. The eyes are widely separated and are slightly divergent at the vertex.

Handlirsch arrived at the conviction that Cresson, in his description of *belfragei*, included two distinct species and being unable to determine to which the name *belfragei* should be applied, discarded that name entirely and substituted the names *cressonis* and *insignis* instead. Fox in his Synopsis of the Bembicini of Boreal America restored the original name by making *cressonis* Handlirsch a synonym of *belfragei* Cresson and retained *insignis* Handlirsch as a good species. A careful study of the specimens at hand and also of those in the collection of the American Entomological Society of Philadelphia raises the question of the validity of Handlirsch's *insignis*. Structurally it is, as Handlirsch himself points out, essentially like *cressonis* and in

his table Handlirsch makes use of only color differences to separate his two species. These differences, made use of by Handlirsch, represent, as a matter of fact, simply extremes in a variable series, as is shown by the series of specimens I have examined. In the series I find one male that has the labrum, clypeus, lower side of scape, frontal spot, wide anterior and narrow posterior orbits *yellow*—character peculiar to *insignis*. It also has narrow, interrupted, conspicuous fasciae on fourth, fifth, and sixth tergites—characters that distinguish *cressonis*—thus combining in one individual the very characters by means of which the two species have been separated. Other specimens also, both males and females, show a greater or less degree of variation in their maculations and these variations are present in those maculations that we should expect to find relatively constant if they are to be regarded as specific characters. Furthermore, so far as I can discover, there is no variation whatever in structure in either sex. I have, therefore, been forced to conclude that we have only one species variable in color and also somewhat in size and have placed the specimens in Cresson's original species *belfragei*.

Habitat.—Georgia, Louisiana, Texas, Kansas, and Wisconsin.

Number of specimens examined—Males, 11; females, 7.

BEMBIX STENORDOMA, new species.

Figs. 154, 192, 214, 215.

Male.—Black: Labrum, mandibles except apices, clypeus, scape, basal segments of flagellum below, spot between antennae, broad anterior orbits narrowly prolonged onto vertex and joined by a transverse line below anterior ocellus, broad posterior orbits narrowed to a fine line above, prothorax almost entirely, lateral lines and a pair of discal lines on scutum, tegulae, narrow fascia on scutellum enlarged laterally, narrow curved fascia on metanotum, short narrow oblique lines basally on dorsum of median segment, sides of median segment, mesothorax and metathorax entirely, mesosternum except small black spots in front of middle coxae, broad fasciae on tergites 1-6, first slightly narrowed medially, second to sixth biemarginate and also notched medially on anterior dorsal border, apex of seventh tergite, first sternite, second except three anterior black spots, broad fasciae on third and fourth with a median triangular anterior emargination, lateral spots on fifth, apex of sixth, seventh, legs except basal black spots on middle and posterior coxae and narrow black stripe on all femora above, *greenish yellow*. The markings of the scutellum, metanotum, and dorsum of abdomen are more white than yellow; this is true to a less extent of the clypeus while the legs lack the greenish tinge.

The scape is very short, stout, and thick and the flagellum is unusually light in color, shading below from yellow at the base to tawny

at the apex. The flagellum is cylindrical, the first segment smallest in diameter, the last three slightly flattened and decreasing in width imperceptibly to the apical segment, which is very slightly curved and rounded at the apex. Segments 9–11 bear conspicuous pits and 7–8 smaller ones. The seventh is spinose on the posterior surface. The middle femora are dentate below, and the spur at the apex of the middle tibia is curved. The middle metatarsus is unusually short and is bent in outline. The wings are hyaline, veins brown. The pubescence on head, thorax, and base of abdomen is white, short, and sparse, elsewhere on abdomen almost lacking. The second sternite bears a large prominent hooked process; the third, an evident median carina; the fifth, a pair of very small approximated tubercles apically; the sixth, a low broad transverse process whose posterior face is at right angles to the plane of the segment. With respect to this process on the sixth sternite the species resembles *B. belfragei*. The seventh sternite is greatly narrowed, but it is not reduced to the form of a spine.

Length.—16 mm. Described from a single specimen.

Habitat.—Florence, Arizona.

Type.—Male, in collection of American Entomological Society of Philadelphia.

BEMBIX RUGOSA, new species.

Figs. 216, 217.

Female.—Black: Labrum, mandibles except apices, clypeus, anterior orbits, scape and flagellum below, small rounded spot on either side of anterior ocellus, narrow posterior orbits, sides of prothorax united by a narrow line on posterior border of pronotum, tegulae, lateral lines and a pair of short anterior discal lines on scutum, fascia on scutellum narrowed medially, fascia on metanotum, pair of short, broad, oblique lines on dorsum of median segment, spot on mesothorax, broad fasciae on tergites 1–4, first slightly emarginate on anterior middle, second, third, and fourth each with five emarginations on anterior border—i. e., a shallow median notch, a deeper square indentation on either side of this and laterally on either side a shallow sinuation, pair of spots on fifth, lateral spots on sternites 2–4, the last pair quite small, apex of ultimate sternite, femora distally, tibiae, and tarsi, *pale greenish or creamy yellow*.

The antennae are cylindrical, long, and slender. The clypeus is strongly arched, shows a silvery reflection and on the midline at the apical border it bears a very slight depression. The labrum is unusually long and slender, as shown in figure 217. The legs are also slender and longer than usual. The spur at the apex of the middle tibia does not reach the middle metatarsus and the spine on the posterior side is almost equally well developed. The wings are hyaline, the veins brown. The pubescence on head, thorax, and

base of abdomen is white, relatively long and moderately dense; elsewhere on the abdomen short and sparse. The ultimate tergite of the abdomen apically bears short, well-marked lateral carinae that, though not evident in a dorsal view, set off a fairly well defined middlefield, which is strongly wrinkled, a character in which it resembles *B. belfragei*. This character and the unusually long labrum form a pair of distinguishing features by which this species can be readily recognized.

Length.—14 mm.

It is possible that this is the female of the preceding species. Although these two specimens, on which the two species are based, do not resemble one another sufficiently to warrant my associating them as sexes of one species, nevertheless their resemblance to the male and female respectively of *belfragei* causes me to suspect that they may be sexes of a single species.

Described from a single specimen in the United States National Museum.

Habitat.—Arizona.

Type.—Cat. No. 19782, U.S.N.M.

BEMBIX FOXI, new species.

Figs. 155, 156, 193.

Bembex sayi Fox, Proc. Acad. Nat. Sci. Phila., 1895, p. 359, female, male.

Male.—Black: Labrum, mandibles except apices, clypeus, scape below, frons between antennae, broad anterior orbits somewhat shortened and also deflected inward above, spot below anterior ocellus, narrow posterior orbits, posterior border of pronotum, sides of prothorax except irregular spot in front of tubercles, weak lateral lines and pair of short discal lines on scutum, spot on sides of median segment, spot on metapleurae, irregular spot on mesopleurae, fasciae on tergites 1-6, first somewhat widely interrupted, second broadest and inclosing a pair of elliptical dorsal black spots, third with a pair of dorsal anterior emarginations, fourth and fifth similar to the third but with broader and more shallow emarginations, apex of seventh, fascia on second sternite inclosing transverse black area posterior to the median process, lateral spots on sternites 3-7, spot on anterior and middle coxae, femora except basally and line above on first pair, tibiae except line below on first pair, and tarsi, *bright yellow*.

The flagellum is dark above, light or yellowish below; segments 7-8 are slightly spinose on the posterior border; the ultimate segment is somewhat curved and tapers toward the apex where it is roundly but obliquely truncate. The pubescence is white and tolerably well developed on head, thorax, median segment and base of abdomen; it is shortest on the dorsum of the thorax and longest on

sides of thorax and median segment. The middle femora are finely but not deeply serrate. The second sternite bears a large, prominent, hook-like process, of which the backwardly directed distal prolongation, ending in a sharp point, is relatively greater than that of any other species herein described. The sixth bears a pointed, narrow, triangular process whose ventral surface is slightly concave longitudinally.

• *Female*.—Black: Labrum, mandibles except apices, clypeus, scape below, frons between antennae, broad anterior orbits shortened and deflected inward above, spot before anterior ocellus, narrow posterior orbits, posterior border of pronotum, sides of prothorax except irregular spot in front of tubercles, lateral lines and pair of discal lines on scutum, lateral spots on scutellum, spot on sides of median segment, spot on metapleurae, irregular spot on mesopleurae, fasciae on tergites 1-5, first widely interrupted, remainder very narrowly interrupted, second imperfectly inclosing a pair of dorsal black spots, remainder with a pair of broad, shallow, anterior, dorsal emarginations, apex of sixth tergite, lateral spots on sternites 2-5, spot on anterior and middle coxae, femora except basally and upper surface of anterior pair, tibiae except stripe above and below on anterior and middle pairs, and tarsi, *yellow*.

Length.—14 mm.

The flagellum is light below, more so than in the male, and the pubescence is similar to that on the male. The wings in both sexes are hyaline and the sculpturing is of the normal character. On the female and on one male the fasciae on the tergites are very narrowly interrupted, appearing for the most part as if developed in lateral halves that have just failed of uniting on the dorsal midline.

This species in the pattern and color of its maculations resembles very closely *B. troglodytes* Handlirsch, from which the male of this species can be readily distinguished by the presence of the serrate middle femora and spinose antennae. The female is distinguished from *troglodytes* by the absence of any black on the clypeus and by the absence of maculations on the metanotum and dorsum of median segment. The male differs from *spinolae*, *similans*, and *cameroni* in the character of the process on the second sternite, the spinose segments of the antennae and the form of the genital stipes. From the females of these three species the female of this one differs in the character of the maculations. Fox referred the males of this species to *sayi* Cresson, and it was doubtless on these same specimens that he based his description of the male of that species.

Described from two males and one female.

Habitat.—Illinois.

Type.—Male and paratypes in collection of the American Entomological Society of Philadelphia, Pennsylvania.

BEMBEX SPINOLAE Lepelletier.

Figs. 157, 158, 159, 160, 194.

Bembex spinolae LEPELETIER, Hist. Nat., 1845, vol. 3, p. 277.*Bembex fasciata* DAHLBOM, Hymen. Europ., vol. 1, 1845, p. 487, female.*Bembex fasciata* WALSH and RILEY, Amer. Ent., vol. 1, 1860, p. 126, fig. 98.*Bembex spinolae* HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 102, 1893, p. 825.*Bembex spinolae* FOX, Proc. Acad. Nat. Sci. Phila., 1895, p. 357.

Male.—Black: Labrum, mandibles except apices, clypeus, scape and first two flagellar segments below, spot between antennae, broad anterior orbits, narrow posterior orbits, spot on sides of prothorax sometimes extensive and sometimes wanting, tubercles and posterior border of the segment both above and below tubercles variable in extent, tegulae more or less, sometimes small spot on mesopleurae, rarely small lateral spots on scutellum, fasciae on tergites 1-5, all of which may be interrupted medially or all continuous except the first, lateral spots on sternites 2-5, femora distally more or less, tibiae except stripe on posterior surface variable in extent, and tarsi, *light or greenish yellow*.

The antennae are slender and segments 7-9 and sometimes 6 also are spinose on the posterior surface, due to the presence of small pits, of which larger ones are found on 10 and 11. The middle femora are dentate. The second sternite usually bears a prominent median tubercle but this in some specimens is much reduced or wholly wanting. The sixth bears a small median process that is pointed and obliquely directed backward. The seventh bears a median carina more or less pointed posteriorly. The genital stipes vary somewhat, as is shown in the accompanying figures. The variation in the extent of the maculations is great. As a rule the maculations are less extensive on those specimens from the north than on those from the south, but this is by no means universal. The abdominal fasciae may be very narrow or relatively broad, closely approximated or widely separated medially and more or less sinuate in outline. The markings of the thorax also varies.

Female.—Black: Labrum, mandibles except apices, clypeus, spot between antennae, scape and basal part of flagellum below, broad anterior orbits, posterior orbits, spot on side of prothorax variable in extent, tubercles more or less, posterior border of the segment above and below the tubercles variable in extent, spot upon sides of mesopleurae variable in size and sometimes wanting, sometimes spot on sides of median segment, fasciae on tergites 1-5, the first invariably interrupted medially, the remainder in some cases all interrupted medially, in others only part interrupted, and in still others all continuous, lateral spots on sternites 2-4, femora distally more or less,

tibiae, except stripe, of greater or less extent below, and tarsi, *light yellow or greenish white*.

Length.—14–17 mm.

The wings in both sexes are hyaline and the nervures brown. The pubescence is white, relatively short and tolerably dense on head, thorax and base of abdomen; on the remaining segments of the abdomen it is quite short. The punctation in both sexes is of the usual character.

Habitat.—Texas, Kansas, Missouri, Alabama, Florida, Georgia, North Carolina, West Virginia, District of Columbia, Maryland, Pennsylvania, New Jersey, New York, Long Island, Connecticut, Rhode Island, Massachusetts, New Hampshire, Ontario, Ohio, Indiana, Michigan, Illinois, Wisconsin, Iowa, South Dakota.

Number of specimens examined—Males, 41; females, 83.

BEMBIX CAMERONI Rohwer.

Figs. 161, 162, 195.

Bembyx cameroni ROHWER, Proc. U. S. Nat. Mus., vol. 41, 1912, p. 467.

Male.—Black: Labrum, mandibles except apices, clypeus, scape below, very broad anterior orbits abbreviated above, space between insertions of antennae prolonged upward, spot below anterior ocellus, line on posterior border of pronotum, tubercles, sides of prothorax in part, spot on tegulae, small lateral spots on scutum at base of anterior wing, broad fasciae on tergites 1–6, first narrowly interrupted medially, second, third, and fourth biemarginate dorsally and sinuate laterally on anterior margin and on posterior margin acutely emarginate medially, fifth and sixth but slightly emarginate or sinuate, small spot on apex of seventh, lateral spots on sternites 2–5, the greater part of the femora distally, tibiae except spot below on anterior pair, and tarsi, *yellow*.

The middle femora are dentate and the antennae are spinose on the posterior border of segments 5–9. The second sternite bears a prominent hooked process and the sixth a somewhat short, broad, roundly pointed process whose ventral surface distally is slightly concave, presenting a spoon-shaped appearance. The spot before the anterior ocellus is wanting on some specimens, and the line on the pronotum consists of spots. On some specimens the scutellum bears small lateral spots and lateral spots may occur on the sixth sternite.

Female.—Black: Labrum, mandibles except apices, clypeus, scape below, broad anterior orbits shortened above, space between antennae, line on posterior border of pronotum tubercles, sides of the prothorax in part, spot on tegulae, short lateral line on scutum at base of wings, lateral spots on scutellum, fasciae on tergites 1–5, first interrupted, second, third, and fourth biemarginate dorsally and somewhat sinuate

laterally on anterior border, and notched medially on both anterior and posterior borders, more evident on the latter, fifth deeply and acutely notched on posterior middle, central spot on sixth tergite, small lateral spots on sternites 2-5, femora distally, tibiae except spot below on first and second pairs, and tarsi, *yellow*.

In both sexes the flagellum is tawny below and the pubescence is well developed, especially on the males. The eyes are widely separated and their inner margins are approximately parallel. The wings are hyaline and the general build is somewhat robust.

Length.—16-18 mm.

This species seems to be intermediate between *nubilipennis* and *spinolae*, not so large as the former and a trifle larger and more robust than the latter. From the former the males of this species can be readily distinguished by the absence in this species of the secondary lateral processes on the sixth sternite and the presence of an evident spine on the fifth segment of the antennae. From the latter it may be distinguished by the flattened, roundly pointed process of the sixth sternite, the richer color of the maculations, which show less of the greenish tinge, and the presence of the spine on the fifth segment of the antennae, characters not found on *spinolae*.

The female is distinguished from *nubilipennis* by its clear wings and from *spinolae*, and the light banded species closely related to it by the deeper yellow of the maculations, and from the yellow-maculated *similans* by the absence of any maculations upon the mesopleurae and metapleurae.

Habitat.—Mexico, New Mexico, Arizona.

Number of specimens examined—Males, 11; females, 3.

BEMBIX COMATA, new species.

Figs. 163, 164, 165, 196.

Male.—Black: Labrum, mandibles except apices, clypeus, scape below, spot between antennae, broad anterior orbits, very narrow posterior orbits, broken line on posterior border of pronotum, posterior edge of tubercle continued in a line downward and spot on side of prothorax, spot on tegulae, short lateral lines on scutum, broad sinuate fasciae on tergites 1-6, all except the first continuous, apex of seventh tergite, lateral spots on sternites 2-6, femora distally, tibiae except stripe below on first pair, and tarsi, *pale or greenish yellow or soiled white*.

Female.—Black: Labrum, mandibles except apices, clypeus, scape below, spot between antennae, broad anterior orbits, narrow posterior orbits, broken line on posterior border of pronotum, tubercles, spot on sides of prothorax, spot on tegulae, short lateral lines on scutum above base of wings, lateral spots on scutellum, small spot on mesopleurae, spot on sides of median segment, broad sinuate fasciae on

tergites 1-5, all except first continuous, apex of sixth tergite, lateral spots on sternites 2-5, femora distally, tibiae except stripe below on all pairs, reduced in extent on posterior pair, and tarsi, *pale or greenish yellow or soiled white*.

In both sexes the color is the same; the fasciae on the tergites are soiled white, the markings of the head more of a greenish yellow shade and the legs are pale yellow. The flagellum is black above, pale or testaceous below, and on the male segments 7-9 are spinose on the posterior border. The wings are hyaline, the nervures brown. The pubescence is white, relatively long and dense. The middle femora of the males are serrate-dentate below, the second sternite bears a prominent median process scarcely hooked at the posterior end and the sixth bears a smaller, pointed process.

Length.—13-17 mm.

This species is very closely related to *spinolae* on the one hand and *primaestate* on the other. The males of this species differ from those of *spinolae* in having the fasciae on the tergites white, the apical tergite maculated and the greater development of the pubescence; from those of *primaestate* in having the fasciae of the tergites white instead of yellow and in the absence of maculations on the sides of thorax and median segment. In the case of the female it differs from *spinolae* in having the apical tergite maculated and in the greater development of the pubescence. In some specimens of this species, however, the maculation of the apical tergite is obscured or even lacking. From *primaestate* the female of this species is distinguished by the absence of conspicuous maculations on the thorax and median segment.

Habitat.—California, Oregon, Washington, Vancouver, and New Mexico.

Number of specimens examined.—Males, 21; females, 18.

Type.—Cat. No. 19780, U.S.N.M.

BEMBIX PRIMAAESTATE Johnson and Rohwer.

Figs. 166, 167, 168, 197.

Bembex primaestate JOHNSON and ROHWER, Ent. News, vol. 19, 1908, p. 378, female.

Bembex primaestate ROHWER, Proc. U. S. Nat. Mus., vol. 41, 1912, p. 466, fig. 3, male.

Male.—Black: Labrum, mandibles except tips, clypeus, scape and first two flagellar segments below, space between antennae, sometimes spot below anterior ocellus, broad anterior orbits shortened above, posterior orbits, usually posterior border of pronotum but not always, tubercles, sides of prothorax variable in extent, spot on tegulae, spot each on sides of median segment, metapleurae, and mesopleurae, on all three variable in extent or even lacking, broad fasciae on ter-

gites 1-6, first interrupted more or less widely and usually narrowed somewhat toward the midline, remaining fasciae continuous though somewhat constricted at the dorsal midline, their borders sinuate especially the anterior, apex of seventh tergite, posterior lateral spots on sternites 2-6, femora more or less distally and below, tibiae except below on first pair, and tarsi, *greenish yellow*. The yellow on the legs lacks the greenish tinge.

The pubescence on the head, thorax, base of abdomen, and the basal joints of the legs is white and unusually well developed. Segments 7 and 8 of the flagellum are distinctly spinose on the posterior surface and on many specimens also 6 and 9, but less evidently so. The intermediate femora are dentate below. The second sternite bears a median, longitudinal process and the sixth a smaller, narrow, pointed process.

Female.—Black: Clypeus, labrum, mandibles except tips, scape below, spot between antennae, frequently united with spot below anterior ocellus, anterior orbits, posterior orbits, posterior border of prothorax almost wholly, tegulae, narrow lateral lines on scutum, lateral spots on scutellum usually connected by a more or less evident line at posterior border of scutellum, fascia on metanotum, sometimes suppressed, spot on sides of median segment, spot on metapleurae, small posterior and larger anterior spot on mesopleurae, broad fasciae on tergites 1-5, first narrowly interrupted medially, remainder continuous, each biemarginate on anterior dorsal border, deep and evident on second and third, more wide and shallow on fourth and fifth, all with an acute emargination at the middle on posterior border, lateral spots on sternites 2-4, frequently connected by very narrow apical lines, femora distally more or less, tibiae except line below, and tarsi, *greenish white or yellow*. The markings on the thorax, median segment, and legs are yellow, elsewhere greenish white.

Length.—13-17 mm.

The pubescence is white and conspicuous but not so well developed as on the male. The flagellum is light on the lower surface, testaceous on the male, yellowish on the female. On most specimens the sixth tergite of the female is black; on some it is maculated and on some of these the dorsum of the median segment is also maculated. It is difficult to distinguish the less extensively maculated females of this species from the most extensively marked forms of *spinolae*, and likewise in many cases it is hard to separate the males from the males of *similans*.

Habitat.—Colorado, Idaho, Washington, Vancouver, California, New Mexico, and Texas.

Number of specimens examined.—Males, 39; females, 28.

BEMBIX SIMILANS Fox.

Figs. 5, 169, 170, 198.

Bembex similans Fox, Proc. Acad. Nat. Sci. Phila., 1895, p. 358, female, male.

Male.—Black: Labrum, mandibles except apices, clypeus, scape, and first flagellar segment below, lower part of frons, spot in front on anterior ocellus, sometimes wanting, broad anterior orbits, posterior orbits broader below, posterior border of pronotum, sides of prothorax except variable spot in front of tubercles, tegulae, lateral lines on scutum, lateral spots on scutellum, fascia on metanotum sometimes absent, sides of median segment, large spot on metapleurae, large irregular anterior and smaller posterior spot on mesopleurae, broad fasciae on tergites 1–6, first abruptly narrowed and usually interrupted medially, remaining fasciae continuous and strongly sinuate on anterior border, the medial pair of sinuations on second and third most conspicuous, lateral spots on sternites 2–6, sometimes connected by apical lines, spot on coxae below, trochanters apically more or less, femora except basally and stripe on posterior surface of anterior pair, tibiae, and tarsi, *yellow*.

Segments 7–9 of the flagellum are spinose on their posterior border and 10–11 bear shallow excavations or pits. The apical segment is but slightly curved, rounded apically and of uniform width. The middle femora are dentate below. The second sternite may or may not bear a small median process and the sixth a small short pointed one. The seventh is carinate medially.

Female.—The color and maculations of the female are quite similar to those of the male, though the black on the legs is more extensive. On some specimens the tibiae are striped with black below.

Length.—11–16 mm.

We find some variation in both sexes. One male has all the fasciae on tergites continuous; two females have each a pair of discal marks on scutum, the lateral spots on the scutellum united and a well developed curved fascia on the dorsum of the median segment. The ultimate segment is usually black, but in the case of two females the ultimate tergite is broadly marked with yellow and others show a gradation from the black on the one extreme to the yellow on the other. The eyes are widely separated and in both sexes are distinctly divergent at the vertex. The flagellum is yellowish or fulvous below. The head, thorax, and abdomen are covered with short, white, moderately dense pubescence, shorter on the abdomen than elsewhere and better developed on the male than on the female. The wings are hyaline, veins fulvous. According to Fox the scutum of the male is without pubescence; all the males before me have the

scutum distinctly pubescent although the hairs here are somewhat shorter than elsewhere on the thorax.

Habitat.—New Mexico, Arizona, and Florida.

Number of specimens examined—Males, 7; females, 15.

BEMBIX PRUINOSA Fox.

Figs. 171, 172, 199.

Bembix pruinosa Fox, Proc. Acad. Nat. Sci. Phila., 1895, p. 361, female, male.

Male.—Black: Labrum, mandibles except apices, clypeus, scape below, space between antennae, anterior orbits, narrow posterior orbits, narrow line on posterior border of pronotum, rarely wanting, spot on tegulae, small lateral spot on scutum above base of wings, sometimes lateral spots on scutellum, fascia on metanotum sometimes absent, occasionally one or two small spots on side of median segment, fasciae on tergites 1–6, all of which may be broad and continuous or all may be somewhat narrowed and interrupted medially, in either case the anterior border being more or less sinuate on either side the midline, apex of ultimate tergite, posterior lateral spots on sternites 2–6 usually, though not always, connected by narrow apical lines, femora except broad stripe above and basally below, tibiae except stripe below, and tarsi, *white or yellowish white*.

Segment 7 of the flagellum seen from above shows a rather conspicuous though blunt spine on its posterior border and segments 9–11 bear pits or excavations. The second sternite is smooth; the sixth bears a pair of low inconspicuous carinae that diverge basally; the seventh ends in a prominent spine that is broadly grooved ventrally and bifid apically. The middle femora are smooth.

Female.—Black: Labrum, mandibles except apices, clypeus except black spot basally, rarely lacking, scape below, space between insertions of antennae, anterior orbits, posterior orbits, narrow posterior border of pronotum, small spot on tegulae, small lateral spots on scutum above base of wings, curved fascia, sometimes broken into spots, on scutellum, fascia on metanotum, curved fascia on dorsum of median segment sometimes interrupted medially, lower part of lateral angles of median segment sometimes reduced to narrow posterior lateral spots, occasionally small spot on mesopleurae, broad continuous fasciae on tergites 1–5, the first narrowed medially, the remainder bisinuate on anterior border, lateral spots on sternites 2–5, which may or may not be connected by apical lines, tibiae except below and spot on posterior border of anterior pair, and tarsi, *white or yellowish white*.

Length.—16–19 mm.

In both sexes the flagellum is yellowish or tawny below and the apical segment is reddish. The head, thorax, median segment, and

base of abdomen are covered with dense, moderately short pubescence shortest on the scutum, where it is of a brownish color. The remaining segments of the abdomen are covered dorsally with close, fine pubescence, longest on the more apical segments and more evident on the male than on the female. The wings are hyaline, veins dark brown. The eyes are parallel or slightly divergent beneath. In some males the carinae on the sixth sternite are reduced or lacking. The variation in the maculations is not great in either sex, but in both a part or all of the tergal fasciae may be narrowed and interrupted medially. The species is well marked and not likely to be confused with any other species herein described.

Habitat.—New York, Ohio, New Jersey, Florida, Texas, Kansas, Iowa, New Mexico, California, Oregon, and Canada.

Number of specimens examined—Males, 13; females, 17.

BEMBIX BEUTENMULLERI Fox.

Figs. 173, 174, 200.

Bembex beutenmulleri Fox, Journ. N. Y. Ent. Soc., vol. 9, 1901, p. 83, male.

Bembex obsoleta HOWARD, Insect Book, 1904, pl. 4, fig. 36.

Bembyx obsoleta ROHWER, Proc. U. S. Nat. Mus., vol. 41, 1912, p. 467, figs. 6, 7, 8, male.

Male.—Black: Labrum, mandibles except apices, clypeus, spot between antennae, small spot in front of anterior ocellus, scape below, anterior orbits, posterior orbits wanting or reduced to small spots near the lower border of eye, sometimes one or more small spots on sides of prothorax, spot on tegulae, small lateral spots above base of wings on scutum, lateral spots on tergites 1–5, lateral spots on sternites 2–5 and sometimes 6, which may be connected by very fine apical lines, femora distally more or less, tibiae except more or less above, and tarsi, *yellow*.

Segments 3–6 of the flagellum are indistinctly carinate on the posterior surface; seen from above 7 appears slightly bispinose, due to the presence of a small pit on the posterior surface; segments 9–11 bear larger pits. The eyes are slightly divergent at the clypeus. The middle femora are smooth. The second sternite bears a median longitudinal carina never very strongly developed; the sixth bears a pair of small closely approximated median processes near its apical border, and the seventh ends in a median spine grooved on its ventral surface.

Female.—Black: Labrum, mandibles except apices, clypeus, spot between antennae, small spot in front of anterior ocellus, scape below, anterior orbits, posterior orbits interrupted above, pair of small lateral spots on posterior border of pronotum, pair of larger spots on sides of prothorax, the more posterior including part of the tubercles, spot on tegulae, small spots on scutum above base of

wings, small spots on sides of median segment, lateral spots on tergites 2-5, lateral spots on sternites 2-5 connected by faint apical lines, femora distally more or less, tibiae below more or less, and tarsi, *yellow*. The eyes are distinctly divergent toward the clypeus, more so than in the male. The ultimate segment of the tarsi are relatively long and are slender at the base, particularly those of the anterior pair.

Length.—17-19 mm.

The resemblance of the male and female is quite close, and in both the head, thorax, median segment and base of abdomen are covered with relatively short, white pubescence. The punctation of the dorsum of the thorax is fine, close, and regular. The vertex is depressed between the eyes, its middle being noticeably lower than the level of the top of the eyes. The wings are hyaline, veins brown. The flagellum is tawny or fulvous below, lighter in the female than in the male. This species in general appearances resembles very much *hinei*, from which it can be distinguished in the male by the presence in this species of the ventral processes on the second and sixth sternites and the form of the genital stipes, and in the female by the divergent eyes and the character of the ultimate segment of the anterior tarsi.

The type and three paratypes (in the New York Museum of Natural History) are much darker than the specimens on which this description is based. In three of the specimens the clypeus is marked with black basally, none show yellow on the scutum, in all the yellow marks on the abdomen are reduced or wanting and the yellow on the legs is less extensive. In structural characters there are no differences.

Habitat.—California.

Number of specimens examined—Males, 13; females, 1.

BEMBIX OCCIDENTALIS Fox.

Figs. 175, 176, 201.

Bembex occidentalis Fox, Proc. Cal. Acad. Sci., (2) vol. 4, 1893, p. 10, female, male.

Bembex occidentalis HANDLIRSCH, Sitz. Acad. Wissensch. Wien, Math.-Nat. Cl., vol. 102, 1893, p. 868, pl. 3, fig. 13; pl. 7, fig. 38.

Bembex occidentalis Fox, Proc. Acad. Nat. Sci. Phila., 1895, p. 362.

Male.—Black: Labrum, mandibles except apices, clypeus, scape below, median line on frons extending from between antennae to anterior ocellus, broad anterior orbits, prothorax almost entirely, lateral lines on scutum sometimes shortened, pair of longitudinal discal lines on scutum, which lines may be developed into a broken U-shaped mark, fascia on scutellum, fascia on metanotum, curved fascia on dorsum of median segment sometimes interrupted medially,

lateral angles of median segment and sides of same emarginate above, metapleurae, greater part of mesopleurae, broad fasciae on tergites 1-6, first with a more or less extensive medial anterior emargination or inclosing a closely placed medial anterior pair of black spots, second inclosing a pair of dorsal oval black spots that appear in the form of emarginations on some specimens, third to sixth biemarginate on anterior dorsal margin less evident on the more posterior ones, apex of seventh, second sternite except median black line and rarely small anterior lateral spots, third except triangular median anterior black spot, fourth except wide but shallow anterior emargination, narrow biemarginate fascia on fifth, broader fascia on sixth usually with a small triangular median emargination, legs entirely except variable black spots on coxae and trochanters, *yellow*.

Segments 6-8 of the flagellum are very slightly spinose on the posterior border. The middle femora are smooth and the middle tibiae normal. The second sternite bears a more or less prominent median longitudinal carina, and the sixth a pair of small closely approximated processes that diverge slightly toward the base of the segment. When viewed from the side these processes appear as one. The seventh ends in a spine that in some cases is slightly bifid at the apex. The genital stipes, although maintaining the general design, varies somewhat in development.

Female.—Black: Labrum, mandibles except apices, clypeus, anterior orbits, median vertical line on frons, scape below, posterior orbits sometimes prolonged above on occiput, prothorax except median anterior dorsal spot, tegulae, lateral lines on scutum, pair of longitudinal discal lines on scutum, sometimes wanting and sometimes developed into more or less perfect U-shaped mark, fascia on scutellum, fascia on metanotum, lateral angles of median segment and sides of same emarginate above, metapleurae, mesopleurae almost entirely, broad fascia on tergites 1-5, first with a broad shallow medial anterior emargination or inclosing two small black spots, second inclosing a pair of transverse oval black spots, third frequently similar to the second or biemarginate on anterior margin, fourth and fifth biemarginate on anterior border, apex of sixth, second sternite except medial black spot, third except medial anterior black spot, fasciae on fourth and fifth rather narrow and usually biemarginate on anterior border, apex of sixth, legs except a variable amount of black on coxae and trochanters, *yellow*.

Length.—16-20 mm.

This species is conspicuous for its extensive bright yellow markings. In both male and female the eyes are distinctly divergent at the clypeus and in nearly all specimens are golden yellow in the dried specimens. The flagellum is comparatively slender and is yellow below, more so in the female than in the male. The second segment in both

male and female exceeds the combined length of the third and fourth. The mandibles on both male and female are remarkably straight, scarcely curved at the tip, more slender than usual and almost devoid of teeth on the inner border. The reduction of the teeth on the female is very unusual; only one is present and that is vestigial. The pubescence on the head and base of clypeus is long and rather dense; elsewhere on the body it is sparse and quite short. The wings are hyaline and veins brown. The markings on the dorsum of the thorax and median segment in both sexes are variable; at one extreme we find only short lateral lines on scutum, small lateral spots on scutellum and the lateral angles marked with yellow; at the other, broad lateral lines and U-shaped mark on scutum and broad fasciae on scutellum, metanotum and median segment.

Habitat.—Lower California, California, New Mexico, and Arizona. Number of specimens examined—Males, 7; females, 14.

BEMBIX TROGLODYTES Handlirsch.

Figs. 177, 178, 202.

Bembix troglodytes HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 102, 1893, p. 829, pl. 2, fig. 29, male, female.

Male.—Black: Labrum, mandibles except apices, clypeus, lower part of frons, scape except stripe above, spot in front of anterior ocellus, lateral rounded spot on either side of this one, broad anterior orbits, posterior orbits, prothorax almost entirely, tegulae, lateral lines and pair of short discal lines on scutum, lateral spots more or less approximated medially on scutellum, fascia on metanotum, curved fascia on dorsum of median segment usually interrupted medially on the posterior surface of the segment, lateral angles and sides of the segment, metapleurae, large irregular anterior spot and small posterior one on mesopleurae, broad fasciae on tergites 1-6, first narrowly interrupted medially, remainder continuous, second inclosing pair of rounded dorsal spots, third with a similar pair of spots that are usually connected to the anterior black margin, fourth with a pair of anterior emarginations instead of spots, fifth and sixth slightly sinuate, apex of ultimate tergite, apical border of first sternite, broad apical fascia on second, sometimes inclosing a pair of black spots, lateral spots on 3-5 which may be connected by broad apical bands, narrow ones or not at all, sometimes pair of small lateral spots on 6, spot on coxae, trochanters more or less, femora except more or less basally and stripe below on anterior pair, tibiae except sometimes small spot below on anterior pair, and tarsi, *lemon yellow*.

The flagellum is neither spinose nor dentate; segments 4-11 bear specialized areas on their posterior surface, but these do not assume the form of pits or excavations. The middle femora are smooth

below. The second sternite usually bears a prominent median tubercle, but this may appear as a small median carina or be almost entirely lacking; the sixth bears a prominent median process, flattened, broad at base, pointed or slightly truncate at apex and directed obliquely backward. In one specimen this process is decidedly truncate apically and in another smaller one it is almost entirely reduced. There is some variation in the form of the genital stipes, but the figures given show the type.

Female.—Black: Labrum, mandibles except apices, clypeus except pair of black spots basally, spot between insertions of antennae, transverse row of three (or five) spots in front of anterior ocellus, scape below, anterior orbits, posterior orbits, prothorax except anterior median dorsal spot and spot in front of tubercles, tegulae, lateral lines and short pair of discal lines on scutum, lateral spots (sometimes united into a fascia) on scutellum, fascia on metanotum, curved fascia on dorsum of median segment, lateral angles and sides of median segment, metapleurae, mesopleurae almost entirely, fasciae on tergites 1–5, first narrowed and also interrupted medially, remainder continuous, second as in the male inclosing a pair of dorsal spots, third having a similar pair connected with the anterior black border and having on posterior border a deep median notch and lateral sinuations, fourth and fifth each with pair of shallow anterior emarginations and median posterior triangular emargination, apex of ultimate tergite, lateral spots on sternites 2–5, all or part of which may be connected by narrow apical lines, spot on anterior and middle coxae below, femora except stripe above and more or less basally below, tibiae except stripe on anterior pair below, and tarsi, *lemon yellow* with a tinge of greenish in places.

Length.—14–16 mm.

The five females before me vary somewhat in regard to color. Two have the clypeus and the frons, except the spot between the antennae and those in front of the anterior ocellus, entirely black, and four of the five have a median posterior discal mark on the scutum. In the male there is less variation in color, only one of the entire number being without discal marks on the scutum.

The wings in both sexes are hyaline and the pubescence and punctuation are of the normal character.

Habitat.—Mexico, Arizona, New Mexico, and Texas.

Number of specimens examined—Males, 11; females, 5.

BEMBIX MELANASPIS, new species.

Figs. 179, 180, 203.

Male.—Black: Labrum, mandibles except apices, clypeus, scape below, frons below, small spot in front of anterior ocellus and a small round spot on either side of this one, broad anterior orbits narrowed

above and also deflected inward from the margin of the eye, posterior orbits, posterior border of pronotum, sides of prothorax and tubercles except irregular elongated spot in front of the latter, spot on tegulae, small lateral spot on scutum above base of wings, triangular lateral spots on scutellum, curved fascia on metanotum, lateral angles, continued in form of spot on sides of median segment, small spot at spiracles on same, spot on metapleurae, spot on mesopleurae elongated vertically, broad fasciae on tergites 1-5, the first slightly attenuated and narrowly interrupted medially, remainder continuous, biemarginate anteriorly and triangularly notched at the middle on posterior border, pair of spots on sixth and seventh tergites, broad fascia on second sternite, fascia on third broadly and deeply biemarginate on anterior border, fascia on fourth similar to that on third but with anterior emarginations much enlarged, lateral spots on fifth and sixth, spot on coxae below, femora except short basal markings, tibiae, and tarsi, *yellow*. Marks on scutellum and metanotum are nearly white.

The flagellum is simple, neither dentate nor spinose, but segments 5-11 on the posterior surface bear shallow pits. The ultimate segment is very slightly curved and rounded at the apex. The middle femora are smooth and the posterior pair is provided with long white pubescence below. The second sternite bears a prominent hooked process and the seventh a prominent median process, triangular in form, obliquely directed backward, broad at base, flat on the ventral surface, and bluntly pointed at the apex.

Female.—Black: Labrum, mandibles except apices, narrow apical border and lateral apical angles of clypeus, spot between antennae, spot in front of anterior ocellus and a small rounded spot on either side of this one, anterior orbits deflected inward from the margin of the eye above, posterior orbits, prothorax almost entirely, lateral lines on scutum, pair of anterior longitudinal and a posterior transverse discal mark on scutum, fascia on scutellum, broad laterally, narrow medially, fascia on metanotum, broad curved fascia on dorsum of median segment extended downward medially on its posterior surface, sides of mesothorax and metathorax and median segment almost entirely, broad continuous fasciae on tergites 1-5, first emarginate on posterior and anterior middle, second and third each inclosing a pair of elliptical dorsal black spots, fourth and fifth each with a pair of anterior emarginations corresponding to the black spots of the preceding segments, ultimate tergite with a pair of apical spots, lateral spots on sternites 1-5 connected by apical lines, the one on second sternite broad and inclosing black spots, spot on coxae, femora except basally and stripe on anterior pair above, tibiae, and tarsi, *yellow*.

The pubescence is relatively short, white, and moderately dense, more in evidence on the male than on the female. The flagellum is black with a shade of reddish below on the more apical segments. On the female the scape is black. The frons just above the insertion of the antennae is about equal to the width of the eye at the same level. The eyes diverge at the vertex and also a trifle at the clypeus. The wings of the male are slightly but distinctly infumated medially; those of the female are heavily infumated, resembling those of *nubilipennis* Cresson in this respect.

Length.—19–22 mm.

One of the males has only a vestige of the process on the second sternite. The sixth tergite of one male has a complete fascia; on the type it has only a pair of yellow spots and on a third it is entirely devoid of yellow. On one female the clypeus, antennae, and frons, except the spot between the antennae and the three small spots in front of the anterior ocellus, are entirely black. A single female from Arizona has been placed in this species. It has the narrow frons and infumated wings, but the black on the clypeus has been reduced to two small basal spots and the scape is broadly yellow below.

This species stands close to *nubilipennis* Cresson from which it can readily be distinguished in the male by the nonspinose antennae and the simple middle femora. The female differs from Cresson's species by the presence of the black on the clypeus and by the much narrower frons, which in *nubilipennis* is much wider than the eye at the point just above the insertion of the antennae. Described from three males and four females.

Habitat.—California, Arizona.

Type, allotype, and paratypes.—Cat. No. 19808, U.S.N.M.

BEMBIX TEXANA Cresson.

Figs. 181, 182, 204.

Bembex texana CRESSON, Trans. Amer. Ent. Soc., vol. 4, 1872, p. 219, female.

Bembex texana HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 102, 1893, p. 830, pl. 2, fig. 30; pl. 7, fig. 21, female, male.

Male.—Black: Labrum, mandibles except apices, clypeus, scape below, space between insertions of antennae, small rounded spot on either side anterior ocellus, anterior orbits, posterior orbits, line on posterior border of pronotum and propleurae including tubercles, spot on sides of prothorax, spot on tegulae, short line above base of wings on scutum, small lateral spots on scutellum, sometimes small spot on lateral angles of median segment, usually a small spot on metapleurae above base of middle legs, narrow rectangular spot on mesopleurae, fasciae on tergites 1–6, first broad and interrupted medially, second continuous, inclosing a pair of black spots dorsally and constricted medially, third, fourth, and fifth interrupted medially

and emarginate anteriorly on either side the midline, sixth continuous, small lateral spots on ultimate tergite, posterior lateral spots on sternites 1-6 the more anterior ones usually connected by narrow apical lines, spot on anterior and middle coxae below, femora except broad stripe above and basally below, tibiae except stripe below on anterior and middle pairs and on posterior border of anterior pair, and tarsi, *white*, more or less strongly tinged with yellow on head and legs.

Segments 4-11 of the flagellum bear specialized areas on their posterior surface, which, on the more apical ones, take the form of shallow pits. The apical segment is not curved, is a trifle longer than the preceding segment, and is about equal to it in width. The middle femora are smooth. The second sternite usually bears a more or less well developed median carina, but sometimes this is entirely lacking. The sixth bears a well developed process, broadly triangular basally and sharply pointed posteriorly; the seventh bears an evident median longitudinal carina which is bordered on either side basally by a shorter one.

Female.—Black: Labrum except a medial stripe or basal spot in some specimens, clypeus except a pair of basal spots that may be contiguous, mandibles except apices, scape below, space between insertions of antennae, small rounded spot on either side anterior ocellus, sometimes spot beneath it, anterior orbits, posterior orbits, posterior border of pronotum continued on the sides of prothorax and including tubercles, also spot on sides of prothorax, spot on tegulae, usually small spot above base of wings on scutum, small lateral spots on scutellum, spot on sides of median segment near lateral angles and another on metapleurae not always present, narrow rectangular spot on mesopleurae, fasciae on tergites 1-5, first broad and interrupted and somewhat narrowed medially, second continuous inclosing a pair of elliptical black spots dorsally and constricted medially, remaining fasciae interrupted or continuous, biemarginate on anterior border and curved forward on posterior border on either side the midline, lateral spots on sternites 1-5 which may or may not be connected by apical lines, spot on anterior and middle coxae below, femora distally more or less, tibiae except stripe below and also stripe on posterior border of anterior pair, and tarsi, *yellowish white* or *pale yellow*.

Length.—15-18 mm.

In both sexes the head, thorax, and abdomen are covered with rather short and dense pale pubescence, shorter on scutum and abdomen except the basal segment. The wings of the female show a slight infumation medially; those of the male show hardly a trace of this. The females invariably have the two black spots on the base of the clypeus, but these spots vary in development. On some

specimens there are lateral spots on the ultimate tergite and in a few cases all the tergal fasciae are interrupted medially. The black spots in the second tergal fascia are sometimes united with the anterior black border. In the male these spots are usually so connected and fasciae 1 and 4 are almost invariably interrupted, and sometimes 3 and 6 also. The second fascia in the male is always continuous. This is a well-marked species, one not likely to be confused with any other species thus far discovered within the territory covered by this paper.

Habitat.—Georgia, Florida, Louisiana, Texas, and New Mexico.

Number of specimens examined—Male, 58; females, 27.

BEMBIX HELIANTHOPOLIS, new species.

Figs. 183, 184, 205.

Female.—Black: Spot on mandibles, lateral borders of labrum slightly, spot between insertions of antennae, small spot in front of anterior ocellus, small spot on either side of this one, posterior orbits, posterior border of pronotum and sides of prothorax except spot in front of tubercles, spot on tegulae, lateral lines on scutum, pair of short anterior discal lines and median posterior spot on scutum, lateral spots on scutellum, fascia on metanotum, curved fascia on dorsum of median segment, lateral angles and most of the side of median segment, large spot on metapleurae, large spot and a second smaller one on mesopleurae, relatively broad fasciae on dorsal abdominal segments 1–5, first interrupted medially, remainder continuous but notched on midline, second inclosing a pair of black spots, third similar to second, fourth and fifth each with shallow anterior emargination on either side the midline, lateral spots on sternites 1–5, spot on anterior coxae below, femora distally more or less, tibiae except stripe on inner and posterior surfaces, and tarsi, *yellow or greenish yellow*. The marks on the scutellum and metanotum are white. The eyes are divergent at the vertex and the flagellum is but slightly testaceous below.

Male.—Black: Labrum, mandibles except apices, clypeus except small transverse medial spot at base, scape below, space between insertions of antennae, broad anterior orbits, small spot in front of anterior ocellus, small rounded spot on either side of this one, narrow posterior orbits, posterior border of prothorax including tubercles, spot on sides of prothorax, spot on tegulae, small spot on base of anterior wing, spot on scutum above base of wing, lateral spots on scutellum, lateral angles of median segment, two small spots on sides of same, large spot on metapleurae, two spots on mesopleurae, the upper the larger, relatively broad fasciae on tergites 1–5, first interrupted medially, remainder continuous but notched on

both sides at the midline, second inclosing a pair of dorsal black spots, third with a pair of anterior emarginations replacing the spots of the second, fourth and fifth with a shallow emargination on either side the midline, sixth and seventh with a medial spot apically, lateral spots on sternites 1-5 connected on one and two by narrow apical lines, small medial posterior spot on two, spot on anterior and middle coxae below, femora except more or less basally, tibiae, and tarsi, *yellow*. The spots on the scutum and scutellum are *white*.

The flagellum is testaceous below and is neither spinose nor dentate. Segments 4-11 bear small pits on the posterior surface and the ultimate segment is short, scarcely exceeding the length of the preceding segment, curved and rounded at the apex. The eyes are widely separated and are slightly divergent above. The middle femora are smooth. The second sternite bears a prominent median tubercle slightly curved posteriorly; the sixth bears a median, triangular, pointed process whose ventral surface is flattened or slightly concave, and the seventh bears a median carina that is bordered basally on either side by a shorter one.

Length.—4-17 mm.

The pubescence is pale, moderately long and dense, shortest on the scutum and abdomen and about equally well developed on male and female. The wings are hyaline and veins brown. The yellow markings have a greenish tinge and the black is intense, resembling in this respect the color of *B. belfragei*. The lateral angles of the median segment are somewhat prominent. The dark color on the legs is irregularly distributed, especially on the tarsi.

There is some variation in the maculations of the female; those on the scutum may be reduced to short lateral lines above the base of the wings; the fascia on the median segment may be interrupted medially; the marking of the mesopleura may be reduced to a single small spot; and the inclosed black spots on the second and third tergal fasciae may appear as deep anterior emarginations. The female of this species, which stands close to *troglodytes* Handlirsch, has the labrum, scape of flagellum, and ultimate tergite black, whereas *troglodytes* has these parts yellow or maculated with yellow. On the male the scutum, metanotum, and dorsum of median segment are black; on *troglodytes* the metanotum and dorsum of median segment each bears a fascia and the scutum a pair of discal marks. The genital stipites of the two also differ.

Habitat.—Kansas, Texas.

Number of specimens examined—Females, 7; males, 1.

Type (female).—Allotype, and paratypes in the collection of the University of Kansas.

Paratype.—Cat. No. 19885, U.S.N.M.

BEMBIX CONNEXA Fox.

Bembix connexus Fox, Proc. Acad. Nat. Sci. Phila., 1895, p. 360, female, male.

Female.—Black: Labrum, mandibles except apices, clypeus, scape, and more or less of the flagellum below, lower part of frons, spot before anterior ocellus, broad anterior orbits, posterior orbits broad below, sides of prothorax almost entirely, frequently more or less complete narrow line on posterior border of pronotum, lateral lines on scutum usually abbreviated and sometimes wanting, sometimes small lateral spots on scutellum, more or less of the side of the median segment, spot on metapleurae, spot on mesopleurae, broad fasciae on tergites, first interrupted and attenuated toward mid-dorsal line, second inclosing pair of elliptical transverse dorsal spots or bearing a pair of anterior dorsal emarginations and notched at midline on both margins, third similar to the second, fourth, and fifth each bearing a pair of anterior dorsal emarginations and interrupted medially or continuous, apex of ultimate tergite, lateral spots on sternites 2-5 and sometimes 6, median posterior spot on sternites 2-5 in some specimens, on 2-4 in others, and entirely lacking in still others, apical lines connecting the ventral spots on some specimens, spots on anterior and middle coxae, greater part of femora, tibiae, and tarsi, *yellow*.

The pubescence is white, tolerably dense, longest on the head, somewhat shorter on the thorax and base of abdomen. The thorax is closely and evenly punctated; the punctations of the ultimate tergite are coarser than that of the thorax and the sides of the segment are provided with long white pubescence amid which are found several short black spines.

The male is smaller. There is a broad yellow line on the posterior border of the pronotum and the sides of the prothorax are almost wholly yellow. There are conspicuous lateral lines on the scutum, lateral spots on the scutellum, fascia on metanotum, lateral spots on dorsum and spots on the posterior surface of the median segment, its lateral angles and sides broadly, and sides of mesopleurae and metapleurae almost entirely yellow. The fasciae on the tergites are broad and, except the first, continuous. The second incloses a small pair of black spots; 3-5 are biemarginate on anterior dorsal margin, and the seventh is maculated apically. There are lateral spots on the sternites but none are connected by apical lines. In other respects the maculations are similar to those of the female. Segments 6-8 of the flagellum are spinose on the posterior surface. The middle femora are serrate. The second sternite bears a well developed process and the sixth a smaller one.

Length.—16-20 mm.

This species is large and robust, conspicuous for its intense black color and bright greenish yellow markings. Not a great deal of

variation is present in the maculations. On one specimen there is a pair of faint discal lines on the scutum and on all there is a more or less suppressed dusky band down the middle of the labrum. This is usually reduced to a dusky spot at the base of the labrum but in one specimen it forms a black median stripe the full length of that organ.

On Fox's type (female) of this species the yellow on the dorsum of the mesothorax is limited to small lateral spots on the scutum; the metanotum and dorsum of median segment are not maculated. The sides of the thorax and median segment, however, are broadly maculated. The color of the fasciae on the tergites is whitish like that of *texana*. None of them inclose black spots, the first and fifth are interrupted, the second and third are not notched at all posteriorly, and the fourth is but slightly so. The emarginations on 2-4 are shallow and widely separated. The lateral spots on the sternites are connected and there is a median spot on 2-5. The sixth sternite has a pair of lateral spots and all ventral maculations are yellow.

Habitat.—Utah, California, Nevada.

Number of specimens examined—Males, 1; females, 8.

REMBIX LATIFRONS, new species.

Female.—Black: Labrum, mandibles except apices, clypeus, scape below, broad anterior orbits deflected inwardly at the vertex, lower part of frons prolonged upward to unite with a spot below anterior ocellus, spot on either side the central one confluent with the anterior orbits, broad posterior orbits prolonged upon the vertex, prothorax entirely, tegulae, lateral lines on scutum very broad anteriorly, U-shaped discal mark on scutum consisting of a pair of longitudinal marks broad anteriorly but greatly narrowed posteriorly where they unite with a broad transverse rectangular mark, fascia on scutellum narrowed medially, metanotum, broad curved fasciae on dorsum of median segment, posterior surface, lateral angles and sides of same entirely, mesopleurae and metapleurae entirely except very narrow lines on sutures, median longitudinal stripe on mesosternum, very broad fasciae on tergites 1-5, first inclosing a pair of closely approximated black spots (confluent with the black base) and showing a shallow emargination on posterior middle, second and third each inclosing a pair of narrow, widely separated elliptical black spots and acutely emarginate on posterior middle, fourth and fifth biemarginate on anterior border, dorsal surface of ultimate tergite, broad fascia and pair of anterior spots on second sternite, broad fascia inclosing a pair of small black spots on third, fascia broadly emarginate on fourth, lateral spots on fifth, coxae and trochanters in part, femora except narrow stripe on posterior surface of first pair and short basal marks on anterior surface of second and third pairs, tibiae except narrow line on posterior surface of first pair, and tarsi, yellow.

The flagellum is tawny below, growing lighter toward the apex. The second flagellar segment is not quite equal in length to the combined length of the third and fourth. The ultimate segment is slightly curved, exceeds the length of the segment immediately preceding it, but is not equal to the combined length of the two immediately preceding it. The frons is wide, exceeding the width of the eye at the level of the insertion of the antennae, and the inner borders of the eyes are almost parallel. The wings are long, reaching almost to the tip of the abdomen, hyaline and the veins are brown. The pubescence is white; on the head it is tolerably long and dense; that on the thorax, median segment and base of abdomen is shorter but equally dense; elsewhere on the abdomen it is very short, rather dense and semi-erect. The punctation is of the usual character.

Length.—17 mm.

This form runs in Handlirsch's table, although not accurately, to *B. occidentalis* Fox; in Fox's table it runs to *B. U-scripta* Fox. It differs from *occidentalis* in the broad frons, the eyes being not at all divergent at the clypeus, in the form of the mandibles and in the relative length of the second flagellar segment; it differs from *U-scripta* in the normal form of the ocelli and in the character of the development of the ultimate tergite. Furthermore, it differs from both of these species in the character of the maculations on the sternites.

Described from a single specimen collected by F. H. Snow at Albuquerque, New Mexico, in the year 1894.

Type.—Female, in the collection of the University of Kansas.

Genus MICROBEMBEX Patton.

Microbembex PATTON, Bull. U. S. Geol. Surv., vol. 5, 1879, p. 364.

B. Bembex aberantes HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 102, 1893, p. 878.

Bembex Fox (part), Proc. Acad. Nat. Sci. Phila., 1894, p. 303.

Microbembex Fox, Proc. Acad. Nat. Sci. Phila., 1895, p. 363.

Microbembex KOHL, Die Gatt. d. Spheg., 1896, p. 434.

Type.—*Bembex monodonta* Say by original designation.

The wasps belonging to this genus vary in length from 8 to 14 millimeters and are relatively more slender than those of the genus *Bembix*. The head is equal in width to the thorax. The compound eyes are large, convex, and naked. The facets near the inner border are very slightly larger than those near the outer; this is more evident on the male than on the female. The inner margins of the eyes are practically parallel and the lower border reaches the mandible. The ocellar cicatrices are similar to those of the genus *Bembix*, but are almost concealed by the dense pubescence on the frons and vertex. The occiput is very narrow, the posterior surface of the head concave, and the temples almost wanting. The mandibles are long, slender, pointed, and devoid of teeth. The maxillae are comparatively long,

but when folded are concealed behind the labrum. The maxillary palpus is composed of three segments, the labial of one. The labrum at the apex is conical and truncate, but is flat at the base where it joins the curved distal border of the clypeus. On some specimens the labrum shows a slight median longitudinal depression. The clypeus is very strongly arched, in fact almost angular, and the distal part of the median prominence is devoid of pubescence, smooth, and shining. The distal margin is strongly curved, almost semicircular. The antennae, which are inserted on the frons, apparently on the suture joining the frons and clypeus, are composed of 13 segments in the male and of 12 in the female. The scape is heavy and exceeds in length any segment of the flagellum. The first segment of the flagellum (pedicel) is short, about as long as thick, and the second exceeds in length any of the following segments. Some of the flagellar segments on the male bear secondary sexual modifications.

The thorax is quite similar to that of *Bembix*, but the abdomen is more slender. The ultimate tergite of the female is arched and strongly punctate except on the midline, where there is evidence of a slight longitudinal carina. Laterally the tergite is beset with short spines and it terminates in a median notch, the sides of which may be prolonged into evident spines. The second sternite of the male bears a median process that by its form and development affords specific characters.

The male genitalia consist of a basal piece (cardo), paired stipites, paired sagittae, and median spatha. The base of the stipes is heavy, but the distal part is slender and hirsute and varies in form with the different species. The spatha is short and heavy and distally is cleft below. Near the distal end on either side is a conspicuous rounded enlargement, and the apex is in the form of a tube split below. The sagitta is composed of two parts; the inferior one is short, sparingly hirsute, and more or less concealed; the superior part is strongly chitinized, curved, compressed, dilated distally, and truncate apically.

The legs are moderately long and slender. On the female the first four segments of the anterior tarsus are flattened and the posterior distal angle is greatly prolonged. These four segments are provided with long strong spines that form the tarsal comb used in burrowing. On the male the comb is present but not so well developed. The wings may be infumated or entirely hyaline. On the anterior wing the radial cell is pointed at either end and the distal end does not lie on the costal border. The first cubital cell is as long as the second and third combined. The second cubital cell is narrower on the radial vein than it is on the cubitus, and it receives both discoidal cross veins. The first cubital cross vein is straight, and the third, which curves toward the distal extremity of the wing, forms with the

radius in most cases an acute angle, but in some cases a right angle. The second submedian cell is about equal in length to the first and increases in width from its proximal to its distal extremity.

On the posterior wing the retinaculum, composed of a row of small hooklets, arises at the origin of the radial vein. The median cell is greatly elongated, and from its distal end two short veins extend toward the distal border of the wing. The cubitus arises distal to the end of the submedian cell, whose posterior distal angle, formed by the submedian and submedian cross veins, is obtuse.

The ground color of the body is black, but in teneral specimens this may appear brown. The color of the maculations varies from pale-yellowish white to rich orange yellow.

KEY TO SPECIES.

Males.

1. Process on second sternite long and curved (fig. 218); clypeus, large spot on mesopleura and large discal spots on scutum yellow.....*aurata*.
1. Process on second sternite otherwise formed; above combination of maculations not present.....2.
2. Process on second sternite hirsute; genital stipes as in fig. 224.....*hirsuta*.
2. Process on second sternite smooth; genital stipes as in fig. 226.....*monodonta*.

Females.

1. Pubescence on head, thorax, and median segment unusually long and dense, very conspicuous on dorsum of median segment.....*hirsuta*.
1. Pubescence not unusually long and dense.....2.
2. Clypeus, scape, mesopleura, and large discal spots on scutum yellow.....*aurata*.
2. Combination of maculations as given above not present.....*monodonta*.

MICROBEMBEX MONODONTA Say.

Figs. 6, 219, 225-230.

Bembex monodonta SAY, Nar. Exp. St. Peters River, Append., 1824, p. 335.

Bembex ciliata LEPELETIER, Hist. Nat., vol. 3, 1845, p. 279.

Bembex monodonta LeCONTE, Say's Complete Writings, 1859, p. 226, male.

Bembex argentifrons CRESSON, Proc. Ent. Soc. Phila., vol. 4, 1865, p. 141.

Microbembex monodonta PATTON, Bull. U. S. Geol. Surv., vol. 5, 1879, p. 362.

Monedula nigrifrons PROVANCHER, Add. Faun. Can., p. 362, male, female.

Bembex monodonta HANDLIRSCH, Sitz. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. 102, 1893, p. 882.

Microbembex monodonta FOX, Proc. Acad. Nat. Sci. Phila., 1895, p. 363.

Microbembex monodonta (and varieties) JOHNSON and ROHWER, Ent. News, vol. 19, 1908, p. 374.

Male.—Black: Labrum in part or entirely, apical border of clypeus or entire clypeus, tubercles, narrow line on posterior border of pronotum, spot on tegulae, lateral line above base of wings on scutum variable in extent, sometimes pair of discal marks on scutum, lateral rectangular spots on scutellum variable in size, fascia on metanotum, curved fascia or pair of oblique lines on dorsum of median segment, sometimes postero-lateral angles of median segment, very fre-

quently spot on mesopleurae, fasciae on tegites 1-6, first usually roundly emarginate on anterior middle, second, and third (sometimes fourth) biemarginate on anterior border, frequently lateral spots on seventh, small lateral spots on second and third sternites, distal part of femora variable in extent, tibiae except spot below on first pair and sometimes on second, tarsi except ultimate segments, *yellow*.

The color of the maculations varies from bright orange to pale greenish yellow and the variation in the extent of their development and in their combination on different individuals is such that the description given above may not apply with absolute accuracy to any single specimen. The clypeus is typically black, but it is frequently bordered with yellow and it may be wholly yellow. The labrum likewise may be entirely black or entirely yellow but it is more frequently black with apical yellow markings. The frons, scape, and flagellum are black. The variation in the maculations of the thorax and abdomen are as great as on the head. The wings may be heavily infumated in medial region or they may be hyaline and in the series before me all degrees of infumation may be found. The pubescence is short and white. On the frons and clypeus, especially on well preserved specimens, it gives a bright silvery reflection. It is shorter on the thorax and shows scarcely any silveriness. Segments 6-8 of the flagellum bear evident pits on the posterior surface; the ultimate segment is rounded apically and only very slightly curved. The second sternite bears a prominent, smooth, median, longitudinal process that terminates posteriorly in a short curved point.

Female.—Black: Labrum wholly or in part, mandibles except apices, usually apical border of clypeus, rarely scape below, narrow posterior orbits, spot on tegulae, lateral lines on scutum, frequently pair of discal marks on same, lateral spots on scutellum, fascia on metanotum, curved fascia on dorsum of median segment, usually spot on postero-lateral angles of same, spot on mesopleurae variable in size, fasciae on tergites 1-5, first roundly emarginate at midline on anterior border, 2-5 biemarginate or bisinuate and usually with median notch on anterior border, sixth tergite apically or with apical lateral spots, lateral spots on sternites 2-3, femora distally, tibiae except line below, on first pair and sometimes on second, and tarsi varying in degree, *pale-yellowish white or yellow*. The wings are distinctly infumated on most specimens, but on some they are almost hyaline. The pubescence on the clypeus and frons is short and dense and gives a silvery reflection; on the vertex it is somewhat longer; on the thorax and abdomen it is short and not conspicuously silvery.

Length.—8-14 mm

As in the case of the male, the variation in the maculations is great. The labrum is usually bordered with yellow but it may be wholly yellow, or, in rare cases, it may be entirely black. This is likewise true for the clypeus. The mandibles also may be entirely black. In the case of some western specimens the scape is yellow below. The scutum frequently bears a pair of prominent discal marks, but the increase or decrease of yellow on the scutum or sides of thorax does not appear to bear any definite relation to the increase or decrease of yellow on other parts of the body. The markings on the females from the eastern part of the United States are for the most part pale-yellowish white, whereas those on the females from the western part are more commonly bright yellow, but yellow forms are found in the East and light ones occur in the West.

Although it is quite possible that, in the large number of specimens before me, collected from such widely separated localities, there may be included distinct varieties or even more than one species, nevertheless I am not able at this time to find characters on which I can make a satisfactory separation.

Habitat.—Florida, Georgia, North Carolina, Virginia, District of Columbia, Maryland, New Jersey, Pennsylvania, New York, Massachusetts, Connecticut, Ohio, Michigan, Wisconsin, Illinois, Iowa, Kansas, Texas, New Mexico, Colorado, Montana, Nevada, California, and Washington.

Number of specimens examined—Males, 197; females, 157.

MICROBEMBEX AURATA, new species.

Figs. 218, 221, 222.

Male.—Black: Mandibles except apices, labrum, clypeus, scape except spot above, narrow shortened anterior orbits, narrow broken posterior orbits, prothorax almost entirely, tegulae, broad lateral lines on scutum, pair of large diamond-shaped discal marks on same, pair of large lateral spots on scutellum, metanotum, broad curved fascia on dorsum of median segment, lateral angles and sides of same, small spot on metapleurae, mesopleurae almost entirely, tergites except a very narrow black basal border and on first tergite a mid-dorsal black spot, sternites except a more or less extensive black basal border, and legs except anterior basal parts of femora, *bright yellow*. Segments 6–8 of the flagellum bear prominent pits on the posterior surface, and the ultimate segment is truncate apically and is distinctly curved. The wings are hyaline. The pubescence on the frons and vertex is tolerably long and dense but is not conspicuously silvery. On the thorax and abdomen the pubescence is short and not conspicuous except on the sides and ventral surface of the ultimate abdominal segment, where it is more evident. The process on the second sternite is large, curved, obliquely directed backward and

pointed. The genital stipites are distinct in shape, yellow in color, hirsute and weakly chitinized.

Female.—The shade of color and the character of the maculations on the female are almost the same as those on the male. As is usual in the case of these wasps the maculations on the female are better developed than on the male; the orbits are more extensive and the black on the legs and abdomen reduced. The pubescence is similar to that on the male with the silveriness on the frons more evident. The sides of the apical emargination of the ultimate tergite are produced into short but evident spines. As in the case of the male the ultimate segment of the flagellum is truncate apically and slightly curved.

Length.—12–14 mm.

The black mark on the mid-dorsal area of the first tergite of the type is replaced on the allotype by an anterior emargination; on the paratypes this mark is obscure or wanting. On one paratype the first two flagellar segments are yellow below and on two others the lateral spots on the scutellum are united on the midline.

Habitat.—California, Arizona.

Number of specimens examined—Males, 3; females, 3.

Type and allotype.—Cat. No. 19672, U.S.N.M. Paratypes in the collection of the University of Kansas.

MICROBEMBEX HIRSUTA, new species.

Figs. 220, 223, 224.

Male.—Black: Tubercles and narrow line on posterior border of pronotum joining them, tegulae, lateral lines on scutum, pair of discal marks on same, pair of large lateral spots on scutellum, metanotum, curved fascia on dorsum of median segment, postero-lateral angles of same, very small spot on mesopleurae, tergites 1–7 almost entirely triangular lateral marks on sternites 2–5, distal part of femora, tibiae more or less especially on posterior pair, basal part of metatarsi of second and third pair of legs, *greenish yellow*. The wings are hyaline. The pits on segments 6–8 of the flagellum are lacking. The process on the second sternite is characteristic of this species; it is short, blunt, not backwardly prolonged and is hirsute. The genital stipites are also very hirsute and are distinct in form from those of *monodonta*.

Female.—Black: Labrum except apex, mandibles except apices, clypeus except a pair of black basal spots, scape below, short anterior orbits, narrow posterior orbits, tubercles joined by a narrow band across the posterior border of pronotum, tegulae, lateral lines on scutum, large lateral spots on scutellum, fascia on metanotum, curved fascia on dorsum of median segment, broad fasciae on tergites 1–5, first very slightly sinuate on anterior middle, remainder slightly bisinuate on anterior border and with a slight median notch, sixth

with lateral apical spots, small lateral spots on sternites 2-4, femora, distally, tibiae except spot on first and second pair below, and tarsi in varying degree, *white or pale-yellowish white*. The wings are hyaline. The frons, vertex, occiput, thorax and median segment are clothed with unusually long, dense, white pubescence, especially conspicuous on the sides of the thorax and on the dorsum and postero-lateral angles of the median segment.

Length.—9-13 mm.

The pubescence on the male is not conspicuously different from that on *mondonta* except that the process on the second sternite is hirsute, but on the female it is so markedly different as to furnish a basis for distinguishing the two species. The maculations show but slight variations; the tarsi may be pale with only a brownish shade or they may be decidedly dusky, the distal segments always darker than the proximal ones; on the males the discal marks on the scutum are frequently lacking, the mesopleura is usually black, and the black basal border of the tergites varies in extent; on the female the clypeus may be wholly yellow or it may have the basal border black; the emarginations or sinuations of the anterior border of the tergal fasciae vary in extent but are never very prominent; on a great many of the females from Arizona the black color, especially on the abdomen, is replaced by brown of varying degrees of intensity. Since the series shows all shades from light brown to black this lighter color is believed to show simply a teneral condition.

Habitat.—Texas, New Mexico, and Arizona.

Number of specimens examined—Males, 19; females, 33.

Type, allotype, and paratype.—Cat. No. 19673, U.S.N.M.

BIOLOGY.

Much valuable work on the biology of various species of Bembicine wasps has been done, especially in Europe, but when we compare the number of species whose life history and habits have been investigated with the number of those about which we know practically nothing we wonder why these interesting insects have been so greatly neglected. With respect to the life-history and habits of species of *Steniolia* I have found in the literature consulted a single observation reported, that given by J. C. Bradley, in which he states that he found *Steniolia duplicata* Provancher in California sleeping in clusters on the stems of plants. Of the habits and activities of species of *Stictiella* I have found no report whatever. Among the species of this genus listed in this paper specimens of two (*formosa* and *melanosterna*) were found that had been collected while holding in their grasp adult forms of diurnal Lepidoptera. The biology of species of *Stictia* and *Bicyrtes* is better understood, but the greatest amount of attention and observation, both in Europe and in America, has been devoted to various species of the genus *Bembix*.

Handlirsch in his monograph gives an excellent summary of what had been discovered with regard to the biology of *Bembix* up to the time when his valuable work was brought out. According to this author the first report we have of observations upon the nesting habits of a species of *Bembix* is that made by Linnaeus in 1745, in which he reports *Bembix rostrata* (*Apis rostrata*) flying about over sandy soil and digging burrows therein, within which the larvae were to be found. What is probably the earliest record of observations on the habits of a Bembicine wasp in this country is that reported by John Bartram in the year 1763¹ in which he says:

I saw several of these wasps flying about a heap of sandy loam: they settled on it, and very nimbly scratched away the sand with their fore feet, to find the nests, whilst they held a large fly under their wings with one of their other feet: they crept with it into the hole, that led to the nest, and staid there about three minutes, when they came out. With their hind feet they threw the sand so dextrously over the hole, as not to be discovered: then taking flight, soon returned with more flies, settled down, uncovered the hole, and entered with their prey.

This extraordinary operation raised my curiosity to try to find the entrance, but the sand fell in so fast, that I was prevented, until by repeated essays I was so lucky as to find one. It was six inches in the ground, and at the farther end lay a large magot, near an inch long, thick as a small goose quill, with several flies near it, and the remains of many more. These flies are provided for the magot to feed on before it changes to the nymph state. Then it eats no more until it attains to a perfect wasp. * * *

But this yellow wasp takes a different method, with great pains digging a hole in the ground, lays its egg, which soon turns to a magot, then catches flies to support it, until it comes to maturity.

In 1809 Latreille, in the *Annales du Museum d'histoire Naturelle*, gives a report of his observations on two species of *Bembix*, *rostrata* and *integra* (*tarsata*). In this article he reports the fact that these wasps feed their young upon flies, and gives a description of the burrows constructed for their nests and a detailed description of the larvae. He points out the fact that although these wasps nest in colonies, each wasp digs a nest for herself, using for this work the stout spines with which the front legs are provided. He states that when the wasp has provided sufficient flies for the nourishment of her young she deposits a single egg in each cell and closes it up. He reports that although *rostrata* uses adult flies to store her nest she does not prey upon a single species, but attacks several. He further states that copulation occurs on the wing.

Lepelletier² gives a very complete account of the nesting habits and mode of copulation of *B. rostrata*. In this account he points out the fact that flies taken by the wasp and stored are not killed but paralyzed. He says:

Je lui enlevai sa proie, et la trouvai dans le même état que celles saisies à l'entrée du nid: d'où je conclus que cette pique met ses victimes dans une espèce de paralysie qui n'est mortelle qu'au bout d'un laps de temps assez considérable pour qu'elles soient dévorées vivantes par la larve du *Bembex*.

¹ Philos. Trans. London, vol. 53, p. 37.

² Hist. Nat., vol. 2, 1841.

Many other investigators have also contributed to the knowledge of the life and activities of *Bembix*, and the names of those to whose works I have had access are given in the bibliography appended. Among these there are two, Fabre and Wessenberg-Lund, whose observations require further consideration here. Fabre maintains that the flies stored by *Bembix* are always dead when placed in the nest, and he suggests three possible explanations of this practice on the part of *Bembix*: (1) *Bembix* does not know how to paralyze her prey; (2) the delicate character of the constitution of the fly is such that death is brought on instead of paralysis; or (3) the nervous system of the fly is not suited to paralysis. Fabre does not state positively that the failure of *Bembix* to paralyze her prey is due to one of these three causes, but he sees no other means of explaining the departure from a practice so universal among the digger wasps. Wessenberg-Lund maintains, as does Fabre, that the flies stored by *Bembix* are killed and not paralyzed when captured; but he rejects Fabre's suggestions as to the probable cause therefor and finds the reason in the structure of the wasp herself. He enters into a critical discussion of the form of the abdomen of various types of wasps and bees and compares the form of the abdomen of those that are known to paralyze their prey with that of those in which the sting is not used for that purpose. He finds that the stalked abdomen, such as is possessed by *Spheg*, is associated with the instinct to paralyze, and arrives at the conclusion that this form of abdomen is necessary for the performance of this function. Consequently his answer to the question, "Why does *Bembix* not paralyze her prey?" is that she can not. Her abdomen is so formed as not to permit her to do so.

Thus, both Fabre and Wessenberg-Lund maintain that *Bembix rostrata* does not paralyze her prey, but each explains this departure from what is the usual practice of digger wasps on different grounds. Fabre finds the cause in the character of the prey, Wessenberg-Lund in the structure of the wasp. If these investigators insist that this departure is true only for *B. rostrata*, as I believe they do, it is possible that they may be right. But if they maintain that this departure is true for all species of *Bembix* they are wrong; for at least one species, *Bembix spinolae* Lepeletier, both possesses this power and makes use of it as the following observations show.

On June 13, 1914 I observed a female of *Bembix spinolae* enter her nest carrying a *Chrysops* fly. After some time, probably about five minutes, she emerged and was captured. I at once dug up the nest and found in the brood chamber a single fly, the one I had seen carried in. Upon the fly, which was lying on its back, was found the newly-laid egg placed in its characteristic position, attached by one end to the thorax at one side just posterior to the base of the wing. I carefully removed the fly and egg from the nest and placed

them in a breeding cell in the basement of my home. The egg of the wasp did not hatch until on June 20, delayed, no doubt, by the low temperature of the room, and the larva died on June 21. On June 23 I removed the dead larva and pinned the fly. This fly was not dead at the time it was pinned and even after the pin had been thrust through the thorax it continued to move its antennae and its legs. In this case a fly paralyzed by *B. spinolae* lived for 10 days and might have lived longer had I not killed it. As will be pointed out farther on the first fly brought to the nest by *spinolae* supports the egg of the wasp until it hatches. Furthermore, so far as my observations go, this fly is not consumed by the larval wasp. If this fly was dead at the time the egg is laid upon it, placed as it is in the warm moist earth, it would in all probability decompose before the egg would hatch and would prove a very unsatisfactory foundation for the support of the larval wasp. In no case where I have taken the fly from the nest within twenty-four hours after the egg was placed upon it has the fly failed to respond to stimulation. All were paralyzed. Just how long they remain in this state in the burrow before death ensues I cannot say. Many of the flies brought in by *spinolae* for the developing larva are dead but by no means all of them. I frequently found in brood chambers, containing half grown larvae, flies that responded readily to stimulation. The Peckhams also report two instances in their observations on *spinolae* in which the fly brought in was not dead but paralyzed.

With regard to the European species *B. rostrata*, which Fabre and Wessenberg-Lund had under observation, I, of course, have had no experience, and the fact that *B. spinolae* can and does make use of her power to paralyze is not a proof that *B. rostrata* does likewise. Lepeletier maintains, as pointed out above, that *rostrata* does paralyze her prey and it is possible that both Fabre and Wessenberg-Lund failed to carry the investigation far enough to discover the whole truth. Be the facts in the case of *rostrata* what they may, Wessenberg-Lund's conclusion that the form of the abdomen of *Bembix* inhibits the power to paralyze can not be accepted; for, in the case of one species of *Bembix* and of two species of *Bicyrtes*, in which genus the form of the abdomen is almost identical with that of *Bembix*, we know the prey is paralyzed. Furthermore, Hartman, in his Observations on the Habits of Some Solitary Wasps of Texas (page 30), reports an observation on *Bembix texana* Cresson, in which the wasp seized and stung a fly that he had caught and fastened down for the express purpose of observing this action on the part of the wasp, and the Peckhams in their observations on *Bembix spinolae* report that they twice observed this species in the act of stinging a fly.

During the summer of 1914 I spent a great part of my time observing the nesting habits of three species of Bembicine wasps: *Bembix spinolae* Lepeletier, *Bicyrtes ventralis* Say, and *Microbembex monodonta* Say. The nesting site was a pile of clean sand on a vacant lot in the city of Washington. The last of these three species I had observed with considerable care the previous summer at Cedar Point, Ohio, and what was observed in Washington simply corroborated the facts previously obtained.

BEMBIX SPINOLAE Lepeletier.

In constructing her nest *Bembix spinolae* digs a sloping tunnel in the sand varying from 5 inches to 1 foot in length and, by enlarging the tunnel at the end, forms a brood chamber which is from 4 to 6 inches below the surface of the ground. These nests are dugged at all times of the day; some females are busy at this work early in the morning, others late in the afternoon. On dark, gloomy days these wasps are inactive; they love the sunshine and the hottest part of the day finds them most active. About an hour is required to construct a nest, but the condition of the sand and the individuality of the wasp are important factors in determining the time required. When the nest is complete the wasp closes the entrance carefully and then attacks the pile of sand thrown up in excavating the nest. This she scatters in all directions and continues to work over the surface until all evidence of the presence of the nest is completely obliterated, which usually requires about five minutes. When this has been done the wasp sets forth in search of prey.

The length of time required to secure the first fly for the new nest varied from 2 to 10 minutes. On the first fly placed in the nest the egg is laid and the time spent in this operation varied from 5 to 12 minutes. On emerging from the nest after depositing the egg the wasp shows renewed interest in the concealment of the entrance to her domicile. She spends as much time in effacing the evidence of the opening of the nest as she did in performing the same operation when the nest had just been completed. In this case she throws the sand from all directions toward the entrance to the nest, whereas in the previous operation she throws it away. *B. spinolae* stops up the burrow not only at the entrance but also at a short distance from the brood chamber. This I found true for every nest investigated. In the evening the female wasp usually returns and spends the night within the nest, but not in the brood chamber. In every case where I found a female within her nest she was found between the obstruction at the entrance and the one near the brood chamber.

The males of *B. spinolae* spend much of their time flying about over the nesting area seeking the females and quarreling among themselves. Copulation occurs on the wing. From time to time the males leave

the nesting area to make excursions to the flowers in the vicinity in order to feed on the nectar and presumably also upon the pollen. The males also dig burrows in the sand, in which they spend the nights and the days too during unfavorable weather. These burrows are short and extend to the depth of only an inch or two below the surface. It is an interesting sight on a hot summer day when a sudden shower comes up to see these males hasten to the nesting area and bury themselves in the sand.

There has been much speculation as to whether *Bembix* rears more than one larva at a time and opinions on this point differ. So far as I am aware no positive evidence bearing on this matter has been presented by other investigators and what I have obtained is not conclusive. In a preceding paper on the nesting habits of *B. nubilipennis* Cresson, it was pointed out that this wasp forms a series of lateral branches from the main tunnel and in these rears her larvae, but the evidence obtained in that brief investigation tends to show that but a single larva is reared at a time. My investigations of the nesting habits of *B. spinolae* give evidence of the same character. On two occasions, when keeping under observation a wasp that was busy carrying flies into her nest, she completed this task and sealed up the nest. The sealing of the nest differs from the ordinary mode of closing it, in that in the latter case only the entrance is closed, whereas in the former the tunnel from the brood chamber to the opening is solidly packed with sand. In each case noted the wasp after completing her task of sealing up the nest searched about for a few minutes, and without going out of my sight, began and completed a new nest within which as soon as complete a fly was placed, upon which an egg was deposited.

No more flies are placed in the nest until the larva emerges from the egg, which usually occurs at the expiration of one or two days after its deposition. The young larva does not leave the egg, but moves upward to the open end of the eggshell to which its posterior end remains attached. From this vantage point it can reach with its head to considerable distance on all sides. In no case observed did the larval wasp devour the fly on which the egg was placed. To do so would deprive the young larva of the advantage it enjoys in the position it occupies—a position that appears to be essential to its feeding upon the food provided by the mother wasp at this time. In no case did I succeed in rearing in my breeding cells a larva that was accidentally detached when small from the fly on which the egg was placed. It is my conviction that the flies on which the young larva first feeds are crushed or macerated for it by the mother wasp. In no case did I find a newly-hatched larva in my breeding cells able to feed upon house-flies that were given to it intact and a number of such larvae died for me before I discovered this. By crushing the flies

thereafter so as to permit the larva to reach the internal organs it fed freely and after a day or two it had no difficulty in feeding upon flies that were given intact.

The larva feeds voraciously, grows rapidly, and the mother wasp is kept busy bringing in food for her hungry offspring. In my breeding experiments the shortest period within which the larva passed from hatching to the formation of its cocoon—that is, the time during which feeding occurred—was four days. From my observations in the field I am inclined to think that the time of feeding in the larval stage, provided weather conditions do not prevent the mother from keeping on hand a plentiful supply of food, is on the average about six or seven days. Although I can not state the exact number of flies consumed by any one larva of this species, I should estimate the number of house-flies required to mature the larva to be at least 50. In my breeding experiments I made a practice of supplying more flies than the larva could consume in a day and then on each morning supplying fresh flies after removing from the cell all partly eaten and untouched flies therein. Consequently the exact number was not determined.

The wasp carries her prey ventral side up beneath her body tightly clasped with her middle legs. She retains her hold upon her prey while opening the nest, resting on the posterior pair of feet while she digs open the entrance with her front pair. Wessenberg-Lund states that *rostrata* lays her fly aside while opening the nest, pausing in her work from time to time to make sure the fly is safe. I never saw *spinolae* lay aside her fly when opening her nest save in cases when the sand had been disturbed so as to make it difficult for her to find the entrance to the nest. In such cases the fly was discarded entirely and left lying on the sand. The Peckhams say of *spinolae* that "sometimes she drops the fly behind her and then, turning around, pulls it in with her mandibles." In my observations I have never seen *spinolae* take a fly into the nest in any way other than the usual fashion. Melander in his article on *Bembix* (see bibliography) makes the following statements:

When the nest is of the requisite depth the wasp carefully covers it with loosened soil, concealing the opening. She then departs to sting a fly whereon to deposit her egg. The fly is carried to the nest and left at the door while the wasp digs through. She then descends to the bottom of the nest and returning to the doorway for the fly brings it down as food for her young one.

It is not possible to say with certainty to which species of *Bembix* these statements refer, but the fact that one of the illustrations in the article is labeled, "Adult of *Bembix spinolae*, enlarged five times," would seem to show that the article was written with this species in mind. Since two other species quite similar to *spinolae* are known to occur in northwestern United States, *primaestate* and *comata*, it

is quite possible that the above observations may refer to one of these.

On leaving the nest the entrance is invariably closed. The rapidity with which the wasp secures flies is shown by the following record of intervals between visits to the nest on each of which a fly was brought in. With wasp No. 29 observations began with the visit at 11.18 a. m., and closed with the visit at 12.30 p. m. The successive intervals between visits were 5, 4, 12, 14, 5½, 11½, 3½, 11½, and 5 minutes. In the case of No. 37 the intervals, beginning at 9.32 a. m. and closing at 11.02 a. m., were as follows: 5, 4, 6, 3, 5, 6, 14, 18, 5, and 24 minutes. These two cases may be taken as fairly representing the energy with which the wasp goes about her task. In each of these nests the larva was nearing maturity.

As soon as the larva ceases feeding it encases itself in a cell or cocoon composed of grains of sand entangled in meshes of silk and firmly cemented together by a hard, tough substance probably furnished from glands in the mouth. When it begins to form its cocoon the larva spins a loose felt-work of silk about it as a foundation for the formation of the cocoon proper. In one case this silken felt-work was attached to the under surface of the glass covering the breeding cell, so that the cocoon formed within it was held above the sand in the cell and was firmly cemented to the underside of the glass. Although this larva was not surrounded on all sides by sand, as is the case when the cocoon is formed in the nest, nevertheless, by some means that were not observed, it succeeded in incorporating grains of sand in the wall of the cocoon.

Two cases coming under my observation throw new light upon the life-history of *B. spinolae*. In the first (No. 37) the nest was constructed and the egg deposited late in the afternoon of June 27, the nest was marked and kept under observation until July 3, when the mother wasp was captured and the nest dugged up. The larva therein was nearly full grown. I placed it in a breeding cell together with the flies found in the brood chamber with it. On July 4 I gave it an additional supply of house-flies and on the morning of July 5 it had begun the formation of its cocoon. The larva was covered at once with sand and the cocoon was complete on July 6. This cell with its contents was then set aside and not inspected again until August 24, when to my surprise I found the adult wasp had emerged and unable to escape had perished in the cell. The date of its emergence is not definitely known. In the second case (No. 48) the egg was laid July 10 and hatched on July 12. The larva began forming its cocoon on the afternoon of July 17 and completed it on July 18. It was this wasp that formed its cocoon without being covered with sand. This cell was also set aside, but after the discovery related above it was closely watched and the adult wasp emerged on September 2. Thus this wasp completed its transformations from egg to

adult between July 10 and September 2—a period of 54 days. In both cases the emerging wasps were females. It follows from this that in this locality *Bembix spinolae* has more than a single brood each year. I may add here that the wasps were still active in the field after September 2.

The prey of *spinolae*, as in the case of other species of *Bembix*, consists of flies. The species found in greatest numbers in the nests opened in the course of my investigations was the common house-fly, due perhaps to the fact that the nesting site was located in a suburb in the city where this fly could be most easily obtained. Some individuals, however, showed a preference for other species, and not a single nest was found in which the flies were all of one species. Below are given the contents of three different nests, each of which contained a larva that I judged to be four or five days old. The flies found in these nests were kindly determined for me by Mr. W. R. Walton.

First nest.

- 2 *Winthemia 4-pustulata* Fabricius.
- 10 *Pseudopyrellia cornucinia* Fabricius.
- 1 *Musca domestica* Linnaeus.
- 2 *Sarcophaga*, species ?

Second nest.

- 1 *Chrysops pudicus* Osten Sacken.
- 1 *Chrysops niger* Macquart.
- 2 *Tabanus coffeatus* Macquart.
- 16 *Odontomyia virgo* Wied.

Third nest.

- 1 *Chrysops lugeus* Wied.
- 2 *Chrysops pudicus* Osten Sacken.
- 1 *Tabanus pumilus* Macquart.
- 1 *Tabanus lasiophthalmus* Macquart.
- 13 *Odontomyia virgo* Wied.

BEMBIX BELFRAGEI Cresson.

All investigators that have observed the habits of species of *Bembix* report that these wasps provision their nests exclusively with dipterous insects. I know of but one exception to this: Hartman in *Observations on the Habits of Some Solitary Wasps of Texas*, page 32, reports *Bembix belfragei* Cresson as provisioning her nest with a large species of bug, a hemipterous insect. He informs me that the specimens on which this observation was based can not now be located. I am strongly of the opinion that identification in this case has been incorrect; that the species reported upon has been a member of the genus *Bicyrtes*. This is, however, only a matter of opinion based on a limited experience with species of the two genera. If *B. belfragei* does provision her nest with hemipterous insects she forms a marked exception among the species of *Bembix* thus far

investigated. Prof. J. S. Hine, in circular No. 6 of the State Crop Pest Commission of Louisiana, page 27, makes a short report of his observations on a species of *Bembix* that was determined for him as *B. belfragei*. I have examined his collection and the specimens bearing the label *B. belfragei* is not that species at all but belong to my new species *B. hinei*.

STICTIA CAROLINA Fabricius.

In the same paper (pp. 20-27) Prof. Hine gives a detailed account of the nesting habits of *Stictia carolina* Fabricius (*Monedula carolina* Drury), the activities of the wasps, the character of the nest and its construction, a description of the larva, its size and mode of feeding, the cocoon and the character and quantity of food consumed. According to his observations these wasps prefer to feed their young on adult horse-flies, although they do not confine themselves exclusively to these flies. Hartman also has investigated the nesting habits of this species and in the paper cited above states that *Stictia carolina* deposits her egg in the empty nest and does not provide food until the egg has hatched. In this respect this species resembles *Microbembex* instead of *Bembix*. In other respects the reports show that its breeding habits are quite similar to those of *Bembix*.

BICYRTES VENTRALIS Say.

The species of *Bicyrtes*, so far as my own observations have gone and so far as is shown by the reports of other investigators, always use hemipterous insects, usually nymphs of the so-called stink-bugs, with which to provision their nests. These insects are paralyzed and in my breeding cells many remained alive for over a week. The nest of *B. ventralis* Say is made in the sand in situations similar to that chosen by *Bembix spinolae*, in fact, I have found them nesting side by side in the same sandy area. The nest of *Bicyrtes* is not so deep as that of *Bembix* and is kept closed only at the entrance. When the nest is constructed and closed *Bicyrtes* goes at once in search of prey. When this is secured she returns to the nest carrying her booty in the same fashion as *Bembix* and in the same fashion retains her hold upon it while opening the nest. The bugs are placed upon their backs in the brood chamber and the egg is deposited upon the first one brought in.

Unlike *Bembix*, *Bicyrtes* does not wait for the egg to hatch before bringing in more food, but proceeds at once to complete the provisioning of her nest, which is usually finished and the nest sealed before the egg has hatched. Usually each nest has but a single brood chamber, but in the course of my investigations I found two each of which had two brood chambers reached from the same entrance. In each case, however, the first chamber was provisioned and sealed before

the second was constructed. If unfavorable weather interferes with the work of the wasp before the nest is completely provisioned, she will return to it later and complete the store of food necessary to develop her offspring. Under such circumstances I have observed *Bicyrtes ventralis* carrying bugs into a nest that contained a half-grown larva. On one occasion, after a few days of adverse weather and while the sand was yet wet, I observed a female *ventralis* open and enter a nest but without carrying in a bug. After a few minutes spent inside she emerged and sealed up the nest. I at once dug up the nest and found within it a half-grown larva, several untouched bugs, and the remains of several more that had been devoured. I placed the contents of the nest in a breeding cell and in due time the larva completed its growth and spun its cocoon. Here it would seem that the mother wasp, after an absence of two or three days caused by rainy weather, visited the nest for the purpose of ascertaining whether the larva had been sufficiently provided for. The fact that she sealed up the nest after the inspection indicates that she found conditions satisfactory and my subsequent investigation proved the correctness of her good judgment.

On June 13 I marked a nest in which the wasp was busily storing bugs. I dug this nest up on June 20 and found the larva safely inclosed in its cocoon. It had passed from egg to mature larva within a week. On June 23 a wasp was observed storing her nest. While under observation she completed the provisioning of this brood chamber and sealed it up. She at once constructed a second brood chamber leading off from the same entrance as the first. She placed a few bugs in this, but night came on before the work was complete. She resumed her task on the morning of June 24, completed provisioning the nest and then sealed it. I then marked the nest, but it was not again visited by the wasp. On June 26 I dug up the nest and placed the contents of the two brood chambers in separate breeding cells. The larva from the brood chamber that was first constructed completed its feeding and began forming its cocoon on June 28; the one from the second chamber, on June 30. The results of further investigations show that the egg usually hatches from forty-eight to seventy-two hours after being deposited. As in the case of *Bembix* the larva moves up to the top of the empty eggshell and remaining with its posterior end attached thereto makes use of this vantage point to reach for food in all directions. The number of bugs placed in a brood chamber varied from 3 to 11. In cases where the number of bugs was large the individuals were smaller than where the bugs were less numerous. The larva completes its feeding in from three to five days, so that the time from newly-laid egg to encased larva is approximately one week.

BICYRTES QUADRIFASCIATA Say.

In the course of my investigations I discovered two nests of *Bicyrtes quadrifasciata*—one at Sandusky, Ohio, and the other at Great Falls, Maryland. In both instances my attention was drawn to the insect by the loud, humming noise she makes as she approaches her nest with her victim. Unlike *ventralis*, which species flies hither and thither over the nesting area in search of her burrow, *quadrifasciata*, when she arrives in the vicinity of her nest, poises in the air several feet above the ground and, while making the humming noise referred to, slowly and steadily descends directly to the entrance to the burrow. The nest at Sandusky contained two bugs, nymphs of a species of *Nerarra*, of which both were paralyzed, and upon one, evidently the first brought in, the egg was placed in the same fashion as that noted for *ventralis*. At Great Falls the wasp was taken at the entrance to her nest as she was about to enter with her first victim.

BICYRTES, species?

Hartman, in his paper cited above, reports upon two species of *Bicyrtes* that were identified for him as *Bembidula parata* Provancher and *Bembidula pictifrons* Smith. I am strongly of the opinion that we have here another case of misidentification. *Bicyrtes* (*Bembidula*) *parata* Provancher was described from California and I have not seen a single specimen of this species from Texas. I suspect that the observations reported by Hartman for *parata* refer either to *capnoptera* Handlirsch or to my new species, *annulata*. With regard to the second species, *B. pictifrons* Smith, no such species, so far as I am aware, was ever described. It is possible that the man who determined the specimen may have meant to write *Monedula pictifrons* Smith instead of *Bembidula pictifrons*, but the character of the observations indicates that the species in question belongs to the genus *Bicyrtes*. It is to be hoped that the specimens on which these determinations were based may yet be located and the identity of the species so carefully observed and reported upon may be positively established.

MICROBEMBEX MONODONTA Say.

The data, on which is based the following discussion of the biology of *Microbembex monodonta* Say, were obtained between June 17 and July 25, 1913, at the Lake Laboratory of the Ohio State University located at Cedar Point, Sandusky, Ohio. This strip of land is a great sand-bar more or less sparsely covered with vegetation. In the immediate vicinity of the Lake Laboratory the surface is very irregular, due to the shifting of the sand by the wind, and on the bottoms and sides of these "blow-outs," where vegetation is exceedingly scarce, these wasps nest in countless numbers. They prefer

the open spaces entirely free from vegetation, but their burrows may be found almost anywhere among the clumps of grass and even under the trees wherever the sand is free from leaves or not hidden by foliage. Although a high wind, when the sand is dry or a violent rain-storm, invariably alters in no small measure the surface of the naked sand, nevertheless such changes in no way discourage these energetic little insects or even seriously interfere with their prosperity.

On June 17 the wasps were found in great numbers flitting about over the sand and many were already at work on the construction of nests. The great majority, however, at this time were males, from which fact it seems that the males emerge somewhat earlier than the females. A number of pupae were dug out of the sand and the insects permitted to emerge in the laboratory. In all 10 insects were secured in this way and all were females. In searching the sands from day to day many emerging wasps were dug out, but only a very few of these were males, and my records show that not a single male was thus discovered after the 1st day of July.

Mating occurs immediately after the female has emerged. The fact that the male emerges in advance of the female appears to be a provision of nature to insure the fertilization of all females. The males are constantly searching the sands for the emerging females, and a female is not long above ground before she is discovered by a passing male and fertilized. The female is usually found and seized by a male before she has made any attempt to fly, and a fierce but brief struggle precedes copulation, the pair rolling about on the sand or in some instances rising into the air. Copulation requires but a brief time, about half a minute, and the male seems capable of fertilizing a number of females. All data secured tends to show that copulation occurs but once. While the females are digging their burrows and searching the sands for food for their young they are continually pestered by the roaming males, every one of which in passing a busy female either hovers about her for an instant or pounces upon her back. In the majority of such cases the male retains his hold but momentarily, apparently realizing very quickly that he has made a mistake; in others a struggle ensues upon the sand and occasionally the male will retain his position on the back of the female for some time, but in all of these cases, and hundreds were observed, not a single mating was effected. At the close of the period of investigation very few males were in evidence and the females in great numbers were digging their burrows in peace.

The nest is a simple unbranched tube and a single larva is reared in each. The young is reared at the extreme end of the burrow, which is enlarged somewhat to form a brood chamber. These burrows are from 8 inches to 1 foot in length from end to end and the brood chamber is from 3 to 6 inches below the surface of the sand.

The variation in the length and depth of the burrow depends a great deal upon its location. If it is constructed on a level spot the brood chamber, as a rule, is not so far below the surface as it is when the burrow is placed on a sloping site, and the wind by shifting the sand may alter its depth, no matter where placed. In no case did I find a burrow branched or with more than a single young within it.

The wasp digs with great rapidity, but the length of time required to complete a burrow varies with the condition of the sand and the abundance and activity of the males. After a rain the sand is wet and heavy and the work is laborious, and when the sand is quite dry and loose it slides down into the entrance as fast as the wasp digs it out. In fact, if the sand is very dry and loose the wasps can not construct their burrows at all, and I have seen them work for half a day without being able to get out of sight in the sand, whereas when the sand is in good condition—i. e., shortly after a rain—a burrow can be completed in the course of two or three hours or even less.

Occasionally we find two and even three females contending for the same burrow, and it is interesting to watch the struggle that ensues. When the contestants are of the same size the argument becomes decidedly strenuous. They push and shove and crowd each other about the entrance to the burrow. One will gain the entrance only to be seized by the wing or hind leg and dragged out by the other, which, on gaining the entrance, is subjected to the same treatment by her rival. Frequently as one of them seeks to enter the burrow the other will pounce upon her back, seize her, and rising on the wing carry her to a short distance and drop her without ceremony upon the sand. These struggles sometimes last for hours with no decided advantage to either and apparently no harm sustained by either. The explanation of these contests apparently lies in the fact that, owing to the great number nesting in the same area, two or more burrows are constructed with their entrances quite close together, so that one wasp in opening her burrow disturbs the entrance to the nest of a neighbor, and if this neighbor is desirous of inspecting her nest at the same time a fight ensues.

When the burrow has been completed a single egg is placed in the brood chamber at the extreme end. This is firmly fastened in an upright position in the sand of the floor of the brood chamber. The egg is white, cylindrical, and rounded at the ends. The eggs hatch in from two to three days, and the larvae at first remain with the posterior part of the body still attached within the egg shell, for the egg is always placed so that the head of the developing larva is uppermost, and it waves its anterior part about in search of food. No food, however, is placed in the burrow until the egg has hatched. In this respect *Microbembex monodonta* resembles *S. carolina* as reported by Hartman. *Microbembex monodonta* feeds its young on dead insects,

which it gathers up from the surface of the sands, instead of capturing and paralyzing living insects by stinging, as do other wasps of similar habits. The food is consequently exceedingly variable, but May-flies and midges were most used, probably because of their abundance on the sands and the consequent ease with which they could be secured.

When the wasp is storing her nest with food it is possible to induce her to take into it insects placed at the entrance while she is inside. In this manner I repeatedly succeeded in having newly-killed May-flies, midges, house-flies, and stable-flies taken into the nest. If a May-fly was disabled but still possessed of life enough to move its legs or wings the wasp invariably appeared afraid of it and refused to touch it when it was placed at the mouth of her burrow. I did not observe a single case in which a wasp attacked and carried off a living uninjured insect, but they did attack and carry off house-flies, stable-flies, and even May-flies that I cast upon the sand after having disabled them to such an extent that they could not fly. In seizing such an insect the wasp appears to sting it, but of this I can not speak with certainty. When one of these insects was seized the wasp invariably bent her abdomen forward, bringing the tip into contact with her victim, thus going through the performances that would be incidental to stinging; but this same performance may sometimes be seen when the wasp seizes a dead and dried insect lying on the sand. I am of the opinion, however, that the instinct to sting still remains, and that whether the prey be a disabled or a dead insect the wasp uses her sting upon it.

One of the most interesting questions met in this investigation is "How do these wasps find the entrance to their burrows?" The results of my observations force me to conclude that they do so through the sense of smell or some power similar to smell. When the wasp has completed her burrow and deposited an egg therein she closes up the entrance by digging the sand into the mouth of the burrow until it is filled. Not content with this she smooths the sand about the entrance and then beginning near it she proceeds outward first in one direction and then in another, throwing the sand behind her and scattering it loosely over the spot where the mouth of the burrow is concealed. When she has finished there is absolutely not a trace of the burrow to be seen. Nevertheless when the wasp returns two or three days later she is able after searching about over the sand for a little while to dig down directly into the mouth of the burrow as readily as if before filling it up she had inserted a stake into it to guide her in opening it again. She can do this no matter how greatly the appearance of the surface has been changed by wind, rain, or the trampling of animals since the time when she so carefully concealed the entrance. I repeatedly altered the appearance of the sand about the entrance to the nest between the visits of the wasp while she was busied in bringing in food, but I never succeeded in confusing her,

though I dashed buckets of water over the surface, placed a small pile of sand over the entrance, or changed the surroundings by placing paper, leaves, and rubbish about the entrance to the nest.

The following is an extreme case: I had been sitting on the sand for almost an hour observing a number of wasps on a day when the stable-fly was causing me great annoyance by biting my ankles, and as a result the sand about my feet had been trampled and disturbed. While fighting the flies I observed a wasp searching about my shoe, which at the time rested flat upon the sand. She flew round and round my foot, lighting first at one point and then at another, evidently trying to find a means of getting beneath it. I moved my foot aside and the wasp after searching the area covered by my shoe began to dig at a point that had been directly beneath it. She dugged down directly into her burrow. Presently she came out, closed the burrow and set forth in search of food. Here it does not seem possible that the sense of sight or the relation of surrounding objects could have been of any possible use in locating the entrance to the burrow, for my trampling had changed everything within 2 feet of the nest, and my foot was directly over the entrance at the time she began her search for her nest.

As stated above, no food is placed in the brood chamber until the egg is hatched, and even then sufficient is not provided at one time for the development of the larva. It is thus necessary for the wasp to open and provision the nest on two or more days. My investigations clearly established the fact that the nest is provisioned at least twice and possibly oftener. When the wasp brings food to the nest she holds it with her intermediate pair of legs tightly clasped beneath her and while resting upon her hind legs she digs open the nest with her front pair. This is neither the easiest nor the quickest way of accomplishing the work of opening the nest, but it is much the safest. If she releases her hold upon her booty it is almost sure to be carried off by another wasp in search of food for her young. Sometimes the dead insect is so large that the wasp is compelled to lay it aside while opening the nest, but this is never done until by trial the wasp finds she can not open the nest while retaining her burden. It is under such conditions that she is most likely to be robbed of her property. She is, however, just as likely to be assailed while holding it but with less danger of losing it. The struggles at the mouth of the burrow for the possession of a dead insect are frequent and furious, the contestants grappling and rolling over and over on the sand. Frequently it happens that the prey is dropped in the struggle and while the pair of contestants are rolling on the sand a third wasp comes along and settles the quarrel by quietly carrying off the coveted treasure. This fighting over food is not limited to struggles for possession at the entrance to a nest, but may occur at any time when two wasps may chance upon a dead insect on the sand at the same time, or when one

in possession of a dead insect is met by one empty-handed. I have frequently seen two wasps fight fiercely for the possession of a dead insect that the victor, after gaining possession of it, discarded as not worth carrying off.

When leaving her nest the wasp invariably closes the opening, but no very careful attempt is made to conceal the point of entrance save when the visits for that day are complete. This species is preyed upon by a number of parasites and this precaution of closing the nest is doubtless to safeguard the nest against these enemies. They do not, however, make any effort to close the entrance while within the nest—a precaution that is practiced by both *B. spinolae* and *B. nubilipennis*.

During the six weeks within which these observations in the field were recorded efforts were being made to rear the larval wasps, but the final results were far from satisfactory. At first I took small bottles filled with moist sand in which artificial cells were made wherein eggs and larvae of different ages were placed. These were put in a box and kept in the laboratory. While this work was in progress the weather was very hot and every attempt ended in failure, the larvae invariably dying before reaching maturity. This method was abandoned and a box filled two-thirds full of sand and provided with a removable top was sunk in the sand so that the top was 4 inches below the surface. In the sand within the box little pits were made and stocked with eggs and larvae of various stages. The cover was placed on the box and the whole apparatus covered to a depth of about 4 inches with sand. All went well for three days; conditions were apparently as nearly normal as need be, but the third day a colony of little red ants found my box and destroyed every vestige of my larval wasps. The box was moved to what was deemed a safe place and restocked. Things flourished for three days, when ants again found the box and left not a trace of the wasps. I next secured shell vials 25 by 80 mm. which I partially filled with sand in which pits were made for the reception of the eggs and larvae. A single egg or larva was placed in each vial and a cork was loosely inserted to keep out the ants and the vials were placed in the sunken box. This plan worked quite well and I succeeded in rearing to maturity several larvae taken at various stages of development and also in carrying two larval wasps through from the egg to maturity and encasement.

On July 17 a number of nests in process of construction were marked and at 5 p. m. of the same day all these nests were completed and closed, save one, which had been abandoned. On the morning of the 18th three of these marked nests were opened before the wasps were astir and each contained an egg in its characteristic position. These were placed in the breeding box. One was destroyed by minute worms, a second was accidentally crushed by a fall of the vial, but the third hatched. This egg was deposited on the afternoon of

July 17; was still unhatched on the morning of the 19th, but was hatched on the morning of the 20th. It was fed daily on freshly killed May-flies, the remains of the supply of food given on one morning being invariably removed before the fresh supply was given on the succeeding day. It completed its growth and began its encasement on July 25. On the 21st another of these marked nests was opened and a larva apparently about 24 hours old was secured. It had been provided with food, but whether on this date or on the 20th could not be determined. This larva was placed in the breeding box, and reared under conditions similar to the preceding. It likewise completed its growth on the 25th but failed to encase. On the 23d another of these marked nests was opened and a larva secured therefrom and placed in the breeding box. This one completed its development on the 26th but failed to encase—due to neglect on my part. In the case of the first two the time from the deposition of the egg to completion of the feeding of the larva was eight days and in the third nine. It is quite probable that the time normally required by the wasp is somewhat greater than this since the character and quantity of food supplied to the larvae in the breeding case was much superior to that usually furnished by the mother wasp.

When the period of feeding is complete the larva encases itself in an elongated egg-shaped cell or cocoon composed of grains of sand held together by threads of silk that are covered with some adhesive substance, probably furnished by glands in the mouth of the insect. My breeding experiments tend to show that the larvae can not encase unless they are buried in the sand. Many larvae brought to maturity in the vials simply spun a flat web of silk in their cells, and perished without forming cocoons whereas others burrowed down into the sand in the vials and readily encased. Others failing to burrow into the sand were covered loosely with sand by filling up the vials. These readily formed their cocoons.

The first encased larva found in the field was secured on June 28 and it is not probable that many mature earlier than this date. Two weeks later encased larvae were very frequently found when burrows were opened. It is not easy to distinguish a newly constructed cocoon from one formed the year before without opening the cocoon. If the cocoons are very carefully removed the newly constructed ones invariably have adhering to them loose silk fibers resembling the web of a spider; these are never present on a cell a year old. The old cells are also somewhat darker, but this is not a reliable criterion. In no instance was a cell found in a brood chamber or among the remains of food. It appears that the larva when it ceases feeding either advances from the brood chamber a short distance into the tunnel where its narrower diameter permits the larva to reach the sand on all sides or, more rarely, makes its way into the sand from the side of the brood chamber. In all these instances where the cell was

discovered before its situation had been disturbed and its relation to the burrow could be positively determined the cell was found in the tunnel of the burrow from one to three inches from the remains of the food left in the brood chamber. Whether the cells found in the sand at one side of the brood chamber (a circumstance that was observed several times) was formed there by the larva, or had been dislodged in the digging or was formed in another tunnel not associated with the brood chamber near it, are questions that I failed to settle to my own satisfaction. The fact that some of the larvae in my breeding vials burrowed for an inch or more into the sand shows that the larva can if it chooses make its way into the sand from the brood chamber without the aid of a tunnel.

After encasing the insect remains in the larval form until the following spring. Just when the change to the pupa state is made—that is, how long the pupa stage lasts—I have not determined, since all the cocoons secured from the sands after I took up my work on June 17, contained either the pupae of the wasp or larvae or pupae of parasites. When the wasp is ready to emerge it cuts off a circular cap from the end of the cell and comes out. All cocoons from which the wasp had emerged were found densely filled with sand, evidently digged back into them by the wasps at the time of emergence.

No very careful attempt to determine the parasites that prey upon *M. momodonta* was made. The most common one is a species of *Bombylid* fly, *Exoprosopa fascipennis* Say, which was repeatedly taken in the act of ovipositing in the sand at the entrance to the burrows of the wasp and a pupa of which was taken from a cocoon of this species. Another parasite taken from a cocoon is a species of *Mutillid* wasp, *Dasymubilla*, species? In addition to these a number of small parasitic flies, probably *Tachinids*, were always busy about the entrance to the burrows awaiting an opportunity to dash into the opening behind the wasp as she entered her nest and deposited an egg upon the food she carried in for her young. The little red ants that interfered with my breeding operations also tunneled through the sand and destroy the contents of every nest that they chance to find.

EXPLANATION OF FIGURES.

Figures 1 to 6, inclusive, were made from microscopic projections of balsam mounts of the wings. They are, therefore, exact in outline and proportions and since all were drawn on the same scale of magnification the relative sizes are shown. No other drawings were made from balsam mounts; they were made directly from the naked objects. In preparing the genital stipites the wasps were relaxed and the genitalia exerted and allowed to dry either attached to the abdomen of the wasp or more frequently detached and mounted on strips of paper placed on the pin. All figures except those of the wings are camera lucida drawings made with a Bausch & Lomb microscope, using a 48 mm. objective and 10× ocular, except in the case of figure 80, where a 16 mm. objective and 5× ocular were used, and in the case of figures 218 to 230, inclusive, where a 48 mm. objective and 15× ocular were employed. Wherever

possible two drawings of the genital stipites of each species were made, an outline drawing of the dorsal aspect of the pair of stipites and a more careful drawing of a single one of the same individual, the stipites being shifted so that the view falls vertically upon its broad expanse. Drawings of a single stipite of a species are of the more careful kind. In a few cases stipites of several individuals of one species are figured to show variation.

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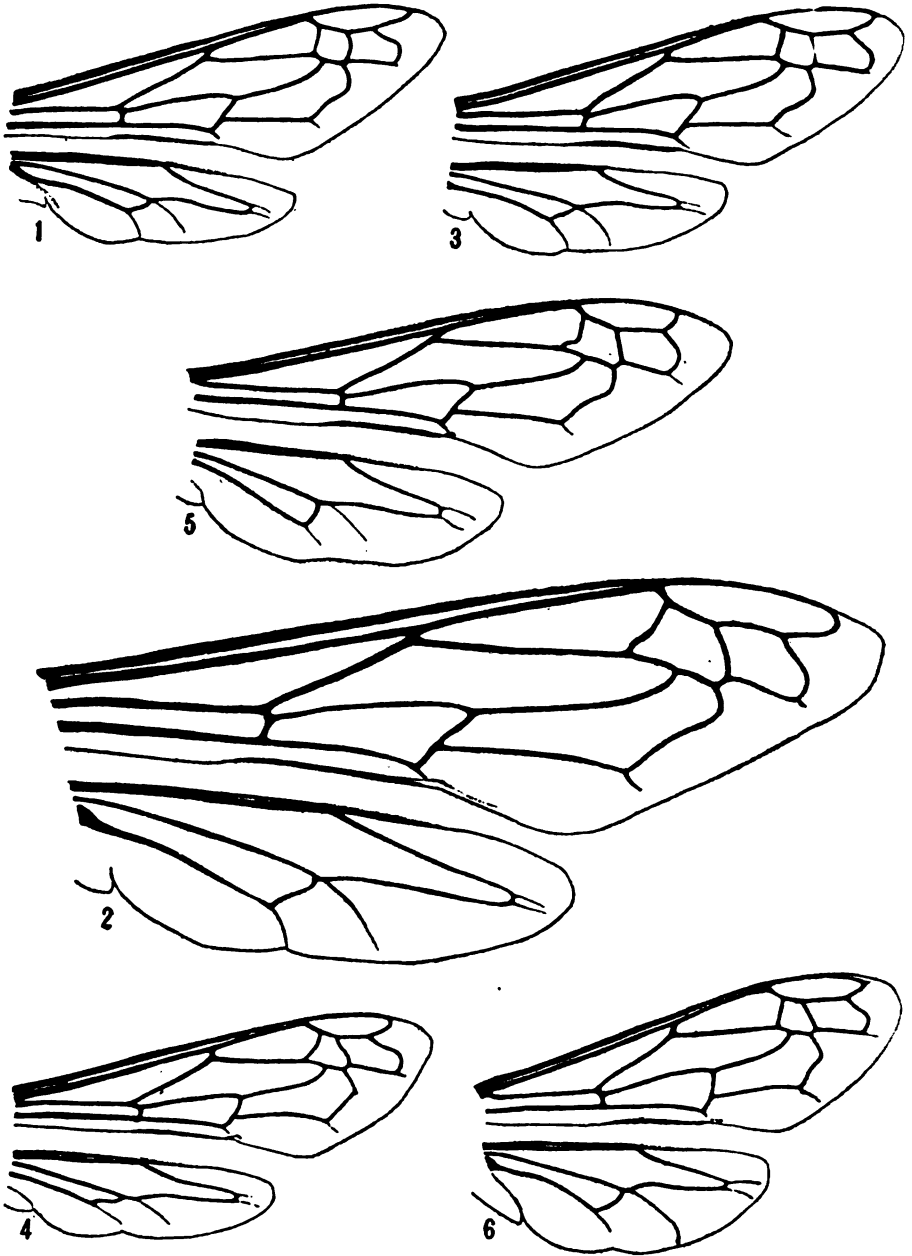
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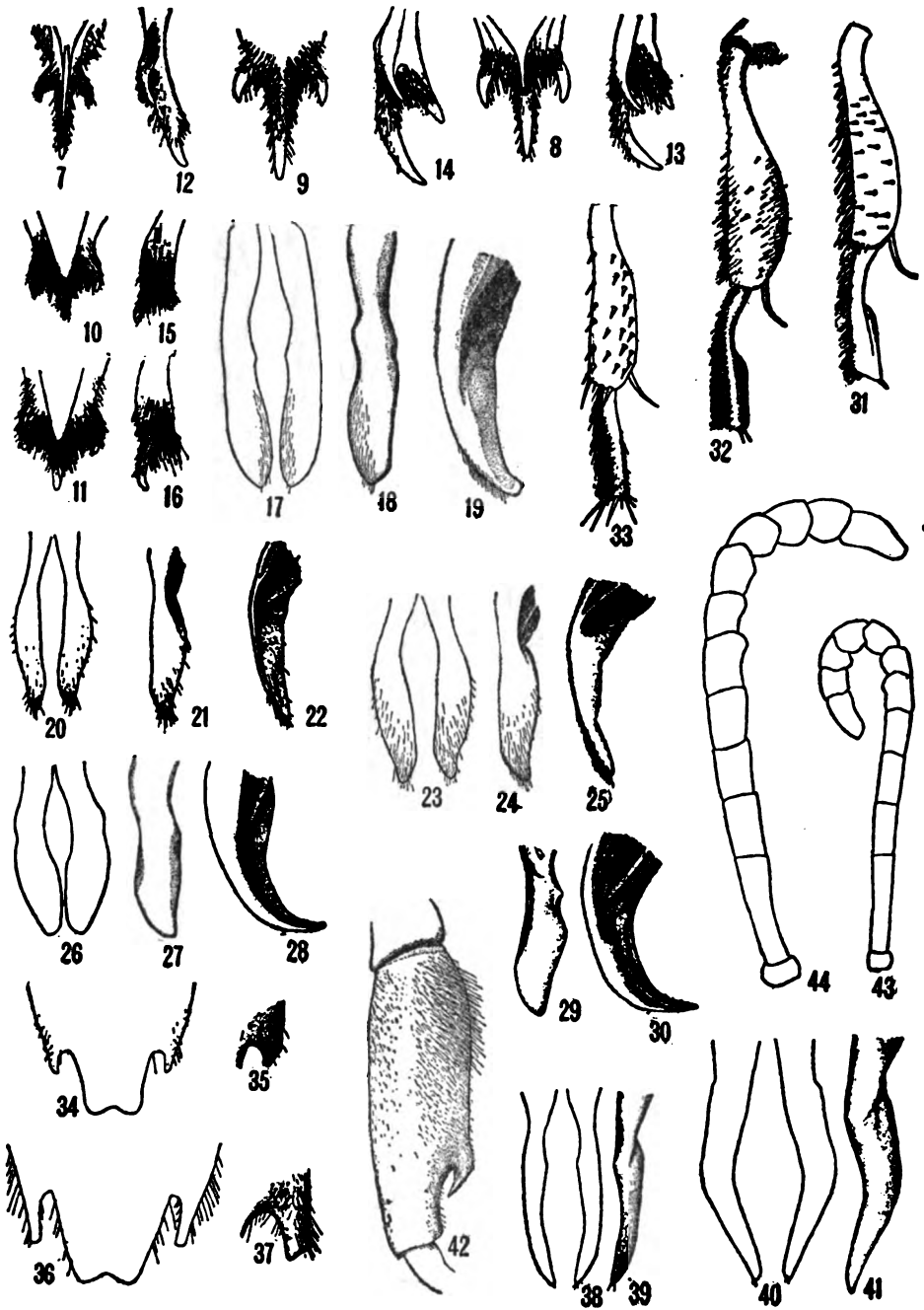
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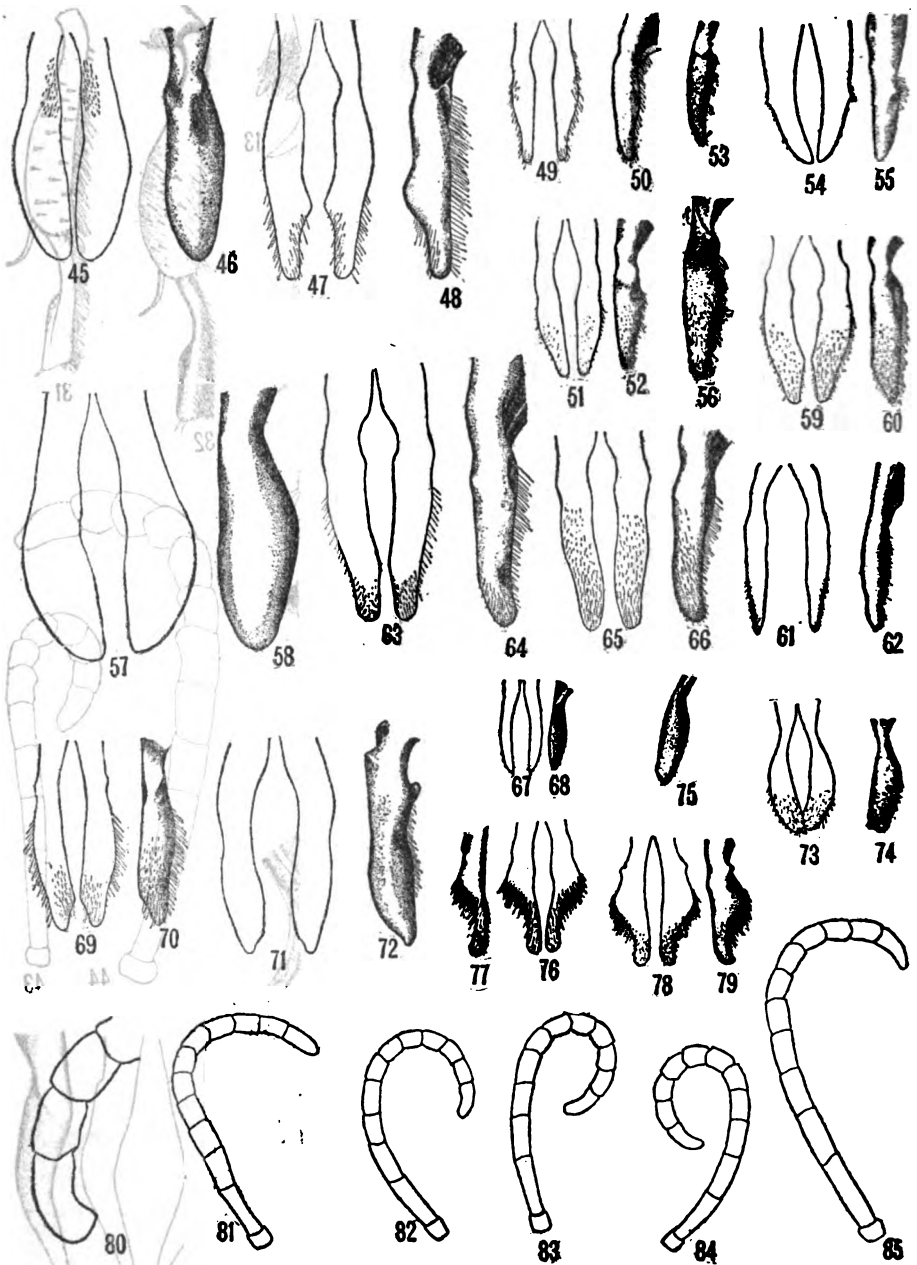
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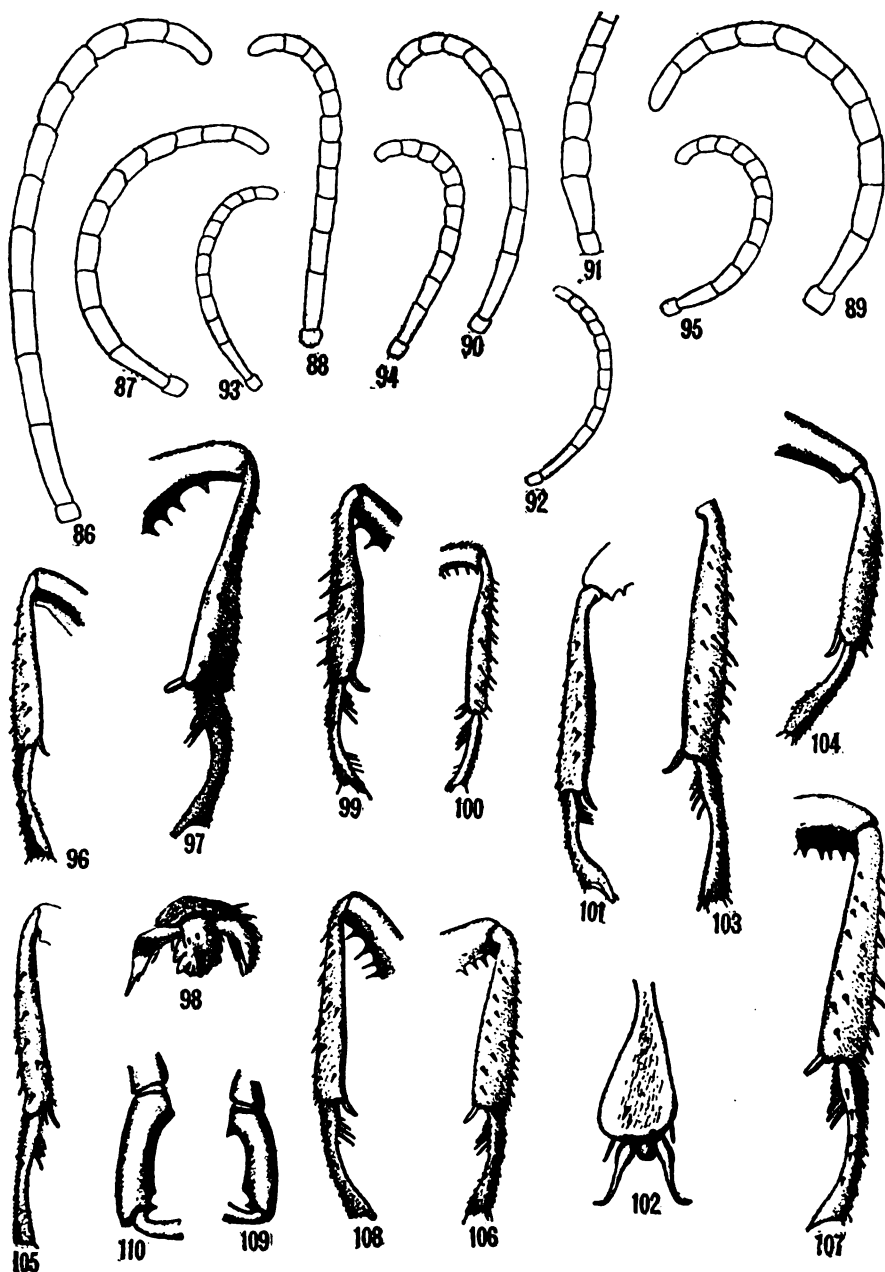
FIGS. 1-6.—WINGS OF 1, *STENIOLIA DUPLICATA*; 2, *STICTIA CAROLINA*; 3, *STICTIELLA VILLOSA*; 4, *BICYTES VENTRALIS*; 5, *BEMBIX SIMILANS*; 6, *MICROBEMBEX MONODONTA*.



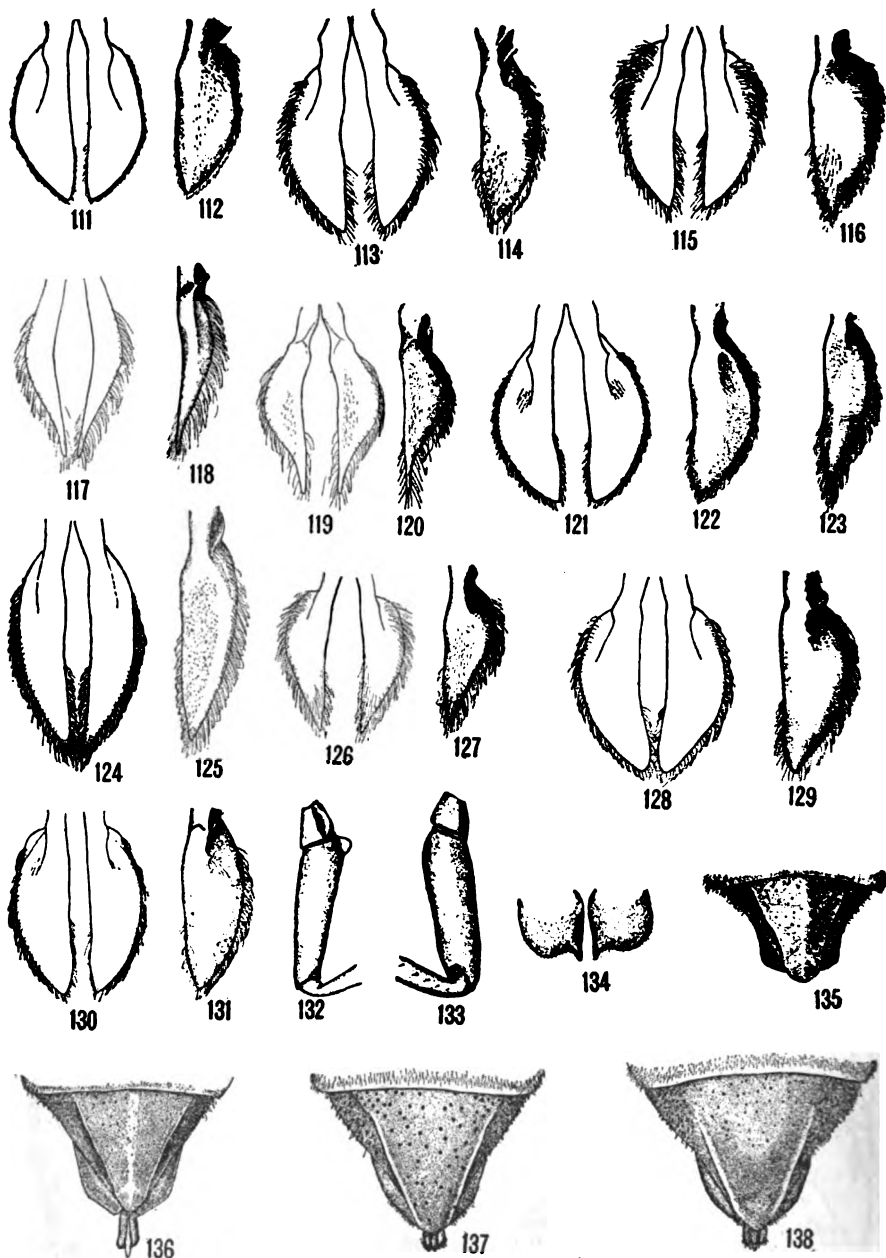
FIGS. 7-44.—EIGHTH STERNITE OF 7, *STENIOLIA NIGRIPES*, VENTRAL VIEW; 8, *S. DUPLICATA*, VENTRAL VIEW; 9, *S. ALBICANTIA*, VENTRAL VIEW; 10, *S. OBLIQUA*, VENTRAL VIEW; 11, *S. TIBIALIS*, VENTRAL VIEW; 12, *S. NIGRIPES*, LATERAL VIEW; 13, *S. DUPLICATA*, LATERAL VIEW; 14, *S. ALBICANTIA*, LATERAL VIEW; 15, *S. OBLIQUA*, LATERAL VIEW; 16, *S. TIBIALIS*, LATERAL VIEW; GENITAL STIPES OF 17-19, *STENIOLIA NIGRIPES*; 20-22, *S. DUPLICATA*; 23-25, *S. ALBICANTIA*; 26-28, *S. OBLIQUA*; 29-30, *S. TIBIALIS*; TIBIA AND METATARSUS OF 31, *STENIOLIA OBLIQUA*, MALE; 32, *S. TIBIALIS*, MALE; 33, *S. TIBIALIS*, FEMALE; 34, SEVENTH TERGITE, *STENIOLIA NIGRIPES*, MALE; 35, LATERAL SPINE, SEVENTH TERGITE, *S. NIGRIPES*, MALE; 36, SEVENTH TERGITE, *S. CAROLINA*, MALE; 37, LATERAL SPINE, SEVENTH TERGITE, *S. CAROLINA*, MALE; GENITAL STIPES, 38-39, *S. NIGRIPES*; 40-41, *S. CAROLINA*; 42, MIDDLE FEMORA, *S. CAROLINA*, MALE; ANTENNA, 43, *S. NIGRIPES*, MALE; 44, *S. CAROLINA*, MALE.



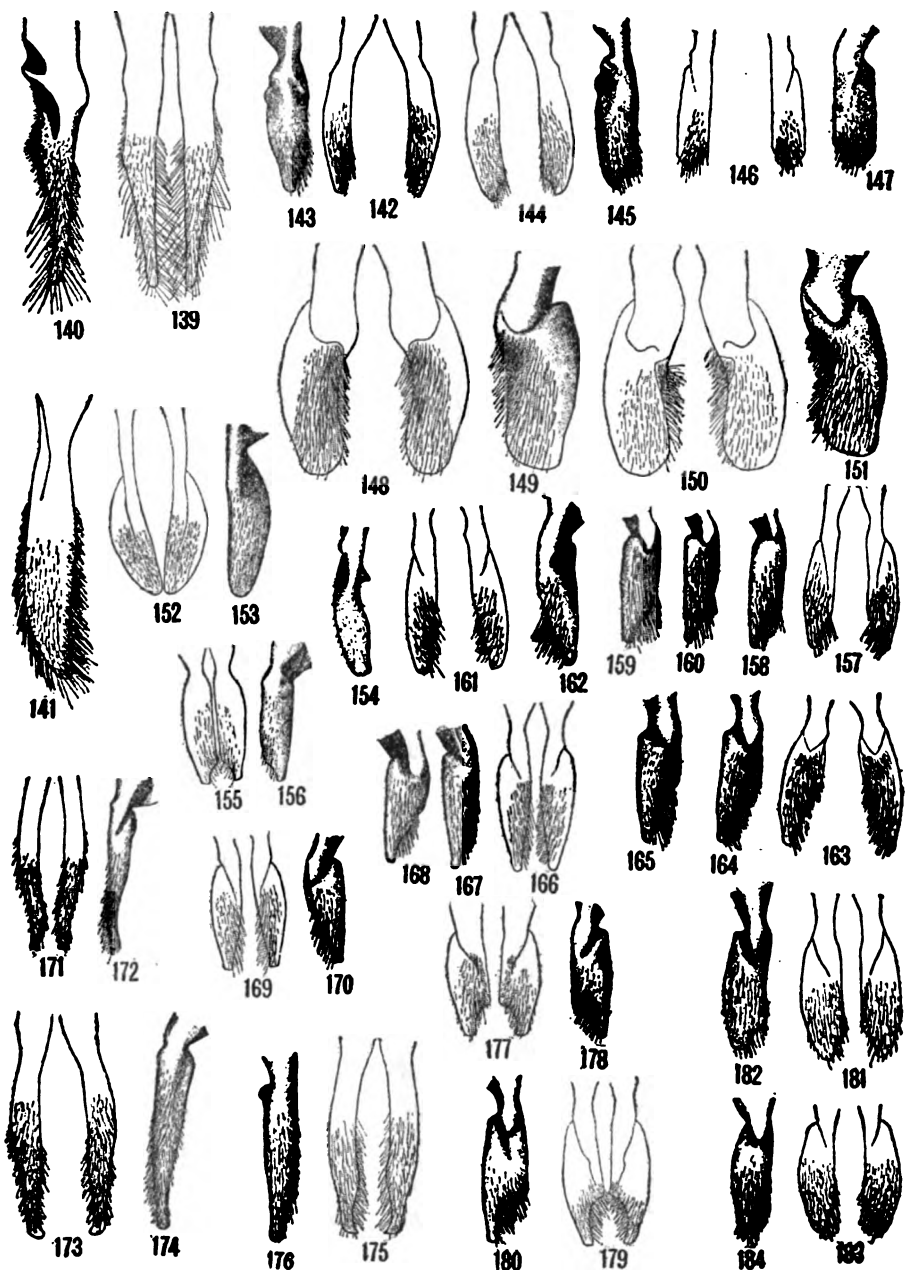
FIGS. 45-85.—GENITAL STIPES OF 45-46, *STICHELLA PICTIFRONS*; 47-48, *S. FORMOSA*; 49-50, *S. MELANOSTERNA*; 51-52, *S. SEBRATA*; 53, *S. PLANA*; 54-55, *S. TUBERCULATA*; 56, *S. CALLESTA*; 57-58, *S. BITUBERCULATA*; 59-60, *S. EMARGINATA*; 61-62, *S. FULCHELLA*; 63-64, *S. SPECTIOSA*; 65-66, *S. MELAMPOUS*; 67-68, *S. VILLOSA*; 69-70, *S. TENUICORNIS*; 71-72, *S. MEGACERA*; 73-74, *S. EXIGUA*; 75, *S. FULLA*; 76-77, *S. FEMORATA*; 78-79, *S. DIVERGENS*; 80, APICAL SEGMENTS, ANTENNA OF *S. PICTIFRONS*, MALE; 81, ANTENNA OF *S. FORMOSA*, MALE; 82, *S. MELANOSTERNA*, MALE; 83, *S. SEBRATA*, MALE; 84, *S. PLANA*, MALE; 85, *S. CALLESTA*, MALE.



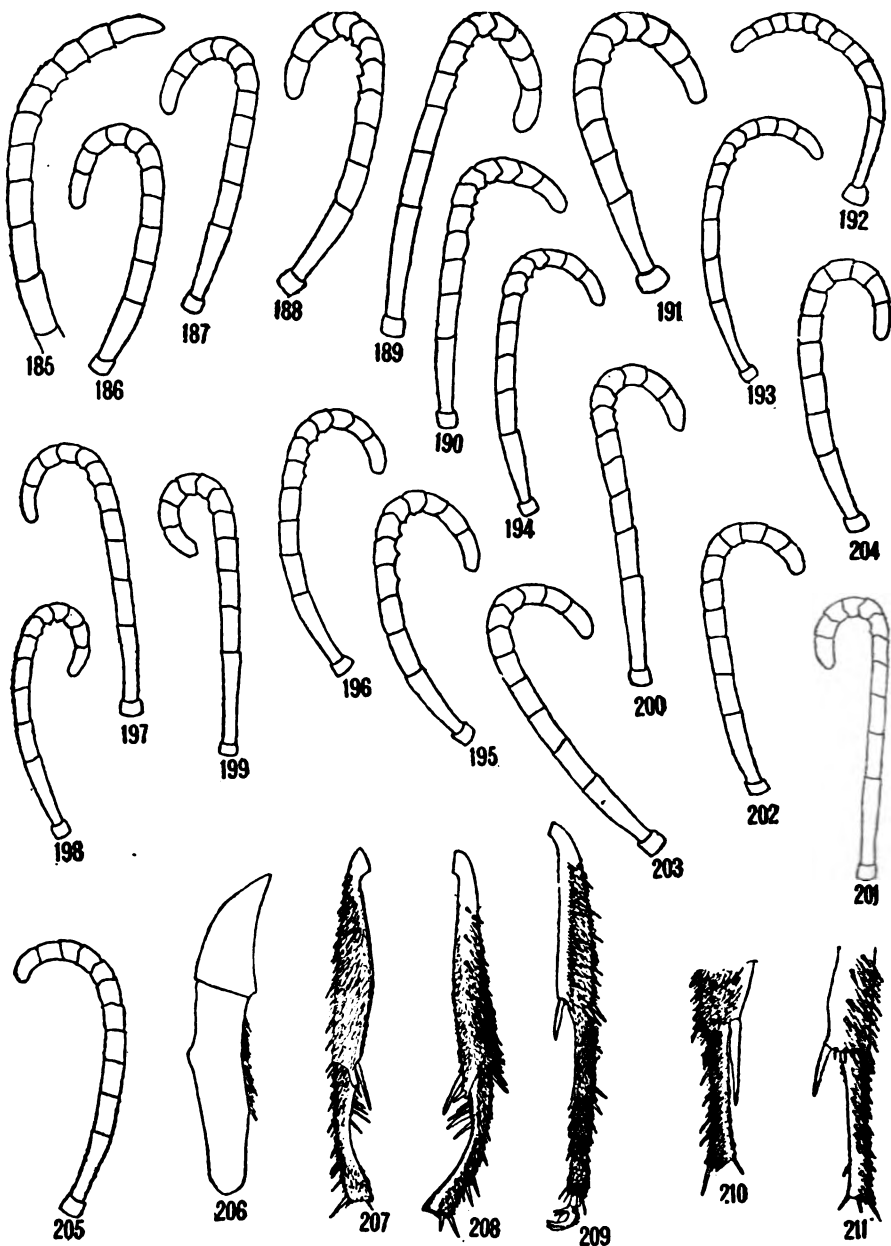
FIGS. 86-110.—ANTENNA OF 86, *STICTIELLA BITUBERCULATA*, MALE; 87, *S. EMARGINATA*, MALE; 88, *S. PULCHELLA*, MALE; 89, *S. SPECIOSA*, MALE; 90, *S. TENUCORNIS*, MALE; 91, *S. MERGACERA*, MALE, BASAL PART; 92, *S. EXIGUA*, MALE; 93, *S. PULLA*, MALE; 94, *S. FEMORATA*, MALE; 95, *S. DIVERGENS*, MALE; 96, MIDDLE TIBIA AND METATARSUS OF *S. PICTIFRONS*, MALE; 97, *S. FORMOSA*, MALE; 98, LAST SEGMENT, LEFT ANTERIOR TARSUS OF *S. FORMOSA*, MALE; 99, MIDDLE TIBIA AND METATARSUS OF *S. MELANOSTERNA*, MALE; 100, *S. ERRATA*, MALE; 101, *S. TUBERCULATA*, MALE; 102, LAST SEGMENT RIGHT ANTERIOR TARSUS OF *S. TUBERCULATA*, MALE; 103, MIDDLE TIBIA AND METATARSUS OF *S. CALLISTA*, MALE; 104, *S. BITUBERCULATA*, MALE; 105, *S. EMARGINATA*, MALE; 106, *S. PULCHELLA*, MALE; 107, *S. SPECIOSA*, MALE; 108, *S. MELAMPOUS*, MALE; 109, MIDDLE TIBIA OF *S. FEMORATA*, MALE; 110, *S. DIVERGENS*, MALE.



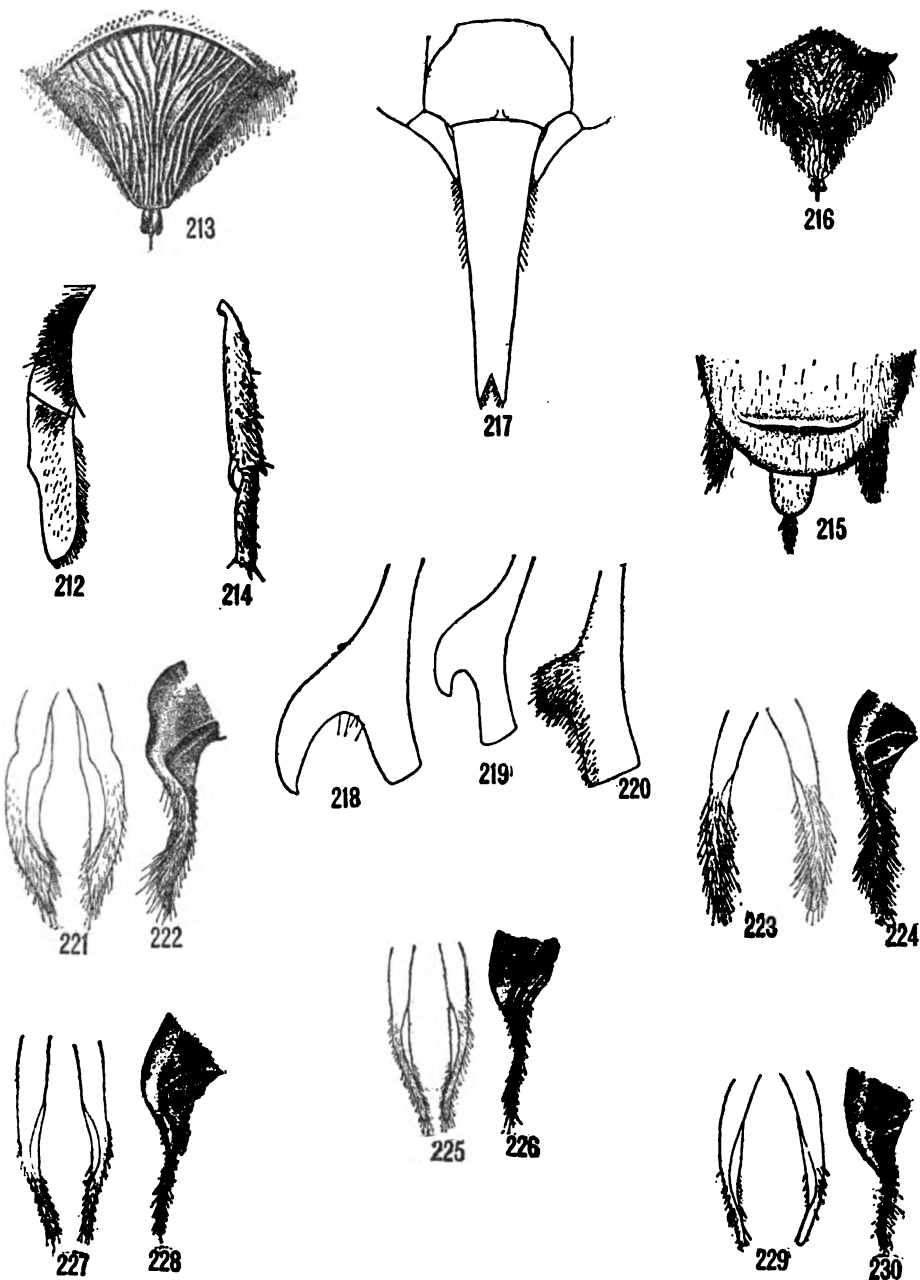
FIGS. 111-138.—GENITAL STIPITES OF 111-112, *BICYTES FODIENS*; 113-114, *B. VENTRALIS*; 115-116, *B. PARATA*; 117-118, *B. 4-FASCIATA*; 119-120, *B. VARIEGATA*; 121-122, *B. ANNULATA*; 123, *B. GRACILIS*; 124-125, *B. VIDUATA*; 126-127, *B. INSIDIATRIX*; 128-129, *B. CAPNOPTERA*; 130-131, *B. MESILLENSIS*; 132, MIDDLE FEMUR OF *B. VENTRALIS*, MALE; 133, *B. CAPNOPTERA*, MALE; 134, POSTERIOR COXAE OF *B. FODIENS*, FEMALE; 135, ULTIMATE TERGITE OF *B. FODIENS*, FEMALE; 136, *B. BURMEISTERI*, FEMALE; 137, *B. ANNULATA*, FEMALE; 138, *B. CAPNOPTERA*, FEMALE.



FIGS. 139-184.—GENITAL STIPITES OF 139-140, *BEMBIX ARCUATA*; 141, *B. U-SCRIPTA*; 142-143, *B. CINEREA*; 144-145 *B. HINKEI*; 146-147, *B. NUBILIPENNIS*; 148-149, *B. AMOENA*; 150-151, *B. SATI*; 152-153, *B. BELFRAGEI*; 154, *B. STENEABDOMA*; 155-156, *B. FOXI*; 157-158, *B. SPINOLAE*; 159-160, *B. SPINOLAE*, SHOWING VARIATION; 161-162, *B. CAMERONI*; 163-164, *B. COMATA*; 165, *B. COMATA*, SHOWING VARIATION; 166-167, *B. PRIMAARSTATE*; 168, *B. PRIMAARSTATE*, SHOWING VARIATION; 169-170, *B. SIMILANS*; 171-172, *B. PRUINOSA*; 173-174, *B. BEUTEN-MULLERI*; 175-176, *B. OCCIDENTALIS*; 177-178, *B. TROGLODYTES*; 179-180, *B. MELANASPIS*; 181-182, *B. TEXANA*, 183-184, *B. HELIANTHOPOLIS*.



FIGS. 185-211.—ANTENNA OF 185, *BEMBIX ARCUATA*, MALE; 186, *B. CINEREA*, MALE; 187, *B. HINEI*, MALE; 188, *B. NUBILIFENNIS*, MALE; 189, *B. AMOENA*, MALE; 190, *B. SAYI*, MALE; 191, *B. BELFRAGEI*, MALE; 192, *B. STENECDOMA*, MALE; 193, *B. FOXI*, MALE; 194, *B. SPINOLAE*, MALE; 195, *B. CAMERONI*, MALE; 196, *B. COMATA*, MALE; 197, *B. PRIMAESTATE*, MALE; 198, *B. SIMILANS*, MALE; 199, *B. FRUINOSA*, MALE; 200, *B. BEUTENMULLERI*, MALE; 201, *B. OCCIDENTALIS*, MALE; 202, *B. TROGLODYTES*, MALE; 203, *B. MELANASPES*, MALE; 204, *B. TEXANA*, MALE; 205, *B. HELIANTHOPOLIS*, MALE; 206, CLYPEUS AND LABRUM OF *B. ARCUATA*, LATERAL VIEW; MIDDLE TIBIA AND METATARSUS OF 207, *B. ARCUATA*, MALE; 208, *B. U-SCRIPTA*, MALE; 209, MIDDLE TIBIA AND TARSUS OF *B. HINEI*, MALE; MIDDLE METATARSUS AND TIBIAL SPUR OF 210, *B. AMOENA*, 211, *B. SAYI*.



FIGS. 212-230.—CLYPEUS AND LABRUM OF 212, *BEMBIX BELFRAGEI*, LATERAL VIEW; 213, SIXTH TERGITE OF *B. BELFRAGEI*, FEMALE; 214, MIDDLE TIBIA AND METATARSUS OF *B. STENEBDOMA*, MALE; 215, VENTRAL VIEW, STERNITES 6-8 OF *B. STENEBDOMA*, MALE; 216, SIXTH TERGITE OF *B. RUGOSA*, FEMALE; 217, CLYPEUS AND LABRUM OF *B. RUGOSA*; PROCESS ON SECOND STERNITE OF 218, *MICROBEMBEX AURATA*, MALE; 219, *M. MONODONTA*, MALE; 220, *M. HIRSUTA*, MALE; GENITAL STIPITES OF 221-222, *M. AURATA*; 223-224, *M. HIRSUTA*; 225-226, *M. MONODONTA* (OHIO); 227-228, *M. MONODONTA* (FLORIDA); 229-230, *M. MONODONTA* (WASHINGTON).

INDEX.

	Page.		Page.
aberantes, B. Bembices.....	117	Bicyrtes annulata.....	67
acknowledgments.....	2	burmeisteri.....	62
albicantia, Steniolia.....	12	capnoptera.....	72
amoena, Bembex.....	88	fodiens.....	60
Bembix.....	88	gracilis.....	68
anatomy.....	3	insidiatrix.....	71
annulata, Bicyrtes.....	67	mesillensis.....	73
arcuata, Bembix.....	81	parata.....	64
argentifrons, Bembex.....	119	quadrifasciata.....	65
belfragei, Bembex.....	92	ventralis.....	62
Bembix.....	92, 131	viduata.....	69
Bembex.....	75	biology.....	123
Bembicini.....	1	burmeisteri, Bembidula.....	62
Bembidula.....	56	Bicyrtes.....	62
Bembix.....	75	callista, Stictiella.....	34
generic description of.....	75	cameroni, Bembix.....	99
key to species of.....	78	Bembyx.....	99
amoena.....	88	capnoptera, Bembidula.....	72
arcuata.....	81	Bicyrtes.....	72
belfragei.....	92	carolina, Bembex.....	20
beutenmulleri.....	105	Monedula.....	20
cameroni.....	99	Stictia.....	20
cinerea.....	84	ciliata, Bembex.....	119, 132
comata.....	100	cinerea, Bembex.....	84
connexa.....	115	Bembix.....	84
foxi.....	96	comata, Bembix.....	100
helianthopolis.....	113	connexa, Bembix.....	115
hinei.....	86	connexus, Bembex.....	115
latifrons.....	116	cressonis, Bembex.....	92
melanaspis.....	109	denverensis, Monedula.....	25
nubilipennis.....	87	diacisa, Monedula.....	56
occidentalis.....	106	divergens, Stictiella.....	55
primaestate.....	101	duplicata, Steniolia.....	10
pruinosa.....	104	edwardii, Steniolia.....	10
rugosa.....	95	emarginata, Monedula.....	38
sayi.....	90	Stictiella.....	38
similans.....	103	exigua, Monedula.....	50
spinolae.....	98	Stictiella.....	50
stenebdoma.....	94	iasciata, Bembex.....	98
texana.....	111	femorata, Monedula.....	53
troglodytes.....	108	Stictiella.....	53
U-scripta.....	83	fodiens, Bembidula.....	60
Bembyx.....	75	Bicyrtes.....	60
beutenmulleri, Bembex.....	105	formosa, Monedula.....	27
Bembix.....	105	Stictiella.....	27
Bicyrtes.....	56, 134	foxi, Bembix.....	96
generic description of.....	56	genera, key to.....	5
key to species of.....	59	gracilis, Bicyrtes.....	68

	Page.		Page.
helianthopolis, <i>Bembix</i>	113	primaestate, <i>Bembix</i>	101
Hemidula.....	2	pruinosa, <i>Bembex</i>	104
hinei, <i>Bembix</i>	86	<i>Bembix</i>	104
inermis, <i>Monedula</i>	25	pulchella, <i>Monedula</i>	40
insidiatrix, <i>Bembidula</i>	71	<i>Stictiella</i>	40
<i>Bicyrtes</i>	71	pulla, <i>Monedula</i>	52
insignis, <i>Bembex</i>	92	quadrifasciata, <i>Bembidula</i>	65
latifrons, <i>Bembix</i>	116	<i>Bicyrtes</i>	65, 134
longirostra, <i>Bembex</i>	5	rostrata, <i>Bembex</i>	124
mamillata, <i>Monedula</i>	38	rugosa, <i>Bembix</i>	95
megacera, <i>Stictiella</i>	49	sallei, <i>Monedula</i>	65
melampous, <i>Stictiella</i>	43	sayi, <i>Bembex</i>	90
melanaspis, <i>Bembix</i>	109	<i>Bembix</i>	90
melanosterna, <i>Stictiella</i>	30	scitula, <i>Monedula</i>	46
meliloti, <i>Bembidula</i>	64	<i>Stictiella</i>	46
mesillensis, <i>Bembidula</i>	73	scolopacea, <i>Steniolia</i>	10
<i>Bicyrtes</i>	73	serrata, <i>Monedula</i>	31
Microbembex.....	117	<i>Stictiella</i>	31
generic description of.....	117	servillii, <i>Bicyrtes</i>	62
key to species of.....	119	signata, <i>Monedula</i>	18
<i>aurata</i>	121	<i>stictia</i>	18
<i>hirsuta</i>	122	similans, <i>Bembex</i>	103
<i>monodonta</i>	119	<i>Bembix</i>	103
minutula, <i>Monedula</i>	40	singularis, <i>Monedula</i>	2
Monedula (<i>Hasselquist</i>).....	2	spinolae, <i>Bembex</i>	98
(<i>Latreille</i>).....	2	<i>Bembix</i>	127
monodonta, <i>Microbembex</i>	134	broods.....	130
ability to find nest.....	137	cocoon.....	130
breeding experiments with.....	139	feeding of larva.....	128
cocoon.....	140	habits of males.....	127
contests at nests.....	136	larva.....	128
copulation.....	135	mode of carrying prey.....	129
larva.....	136	nesting habits.....	127
nest.....	136	oviposition.....	125
nesting site.....	134	power to paralyze.....	125
oviposition.....	136	stenebdoma, <i>Bembix</i>	94
prey.....	137	<i>Steniolia</i>	5
nigrifrons, <i>Monedula</i>	119	generic description of.....	5
nigripes, <i>Steniolia</i>	8	key to species of.....	8
nubilipennis, <i>Bembex</i>	87	albicantia.....	12
<i>Bembix</i>	87	duplicata.....	10
obliqua, <i>Steniolia</i>	12	nigripes.....	8
obsoleta, <i>Bembex</i>	105	obliqua.....	12
<i>Bembyx</i>	105	sulfurea.....	9
occidentalis, <i>Bembex</i>	106	tibialis.....	14
<i>Bembix</i>	106	<i>Stictia</i>	15
parata, <i>Bembidula</i>	64	generic description of.....	16
<i>Bicyrtes</i>	64	key to species of.....	18
<i>Monedula</i>	64	carolina.....	20
pictifrons, <i>Monedula</i>	25	signata.....	18
<i>Stictiella</i>	25	<i>Stictiella</i>	21
plana, <i>Monedula</i>	32	generic description of.....	21
<i>Stictiella</i>	32	key to species of.....	23
primaestate, <i>Bembex</i>	101	bituberculata.....	36

	Page.		Page.
Stictiella callista.....	34	tibialis, Steniolia.....	14
divergens.....	55	troglodytes, Bembex.....	108
emarginata.....	38	Bembix.....	108
exigua.....	50	tuberculata, Monedula.....	34
femorata.....	53	Stictiella.....	34
formosa.....	27	U-scripta, Bembex.....	83
megacera.....	49	Bembix.....	83
melampous.....	43	usitata, Monedula.....	32
melanosterna.....	30	variegata, Bembidula.....	65
pictifrons.....	25	venation of wings.....	4
plana.....	32	ventralis, Bembidula.....	62
pulchella.....	40	Bicyrtes.....	62, 132
pulla.....	52	larva.....	133
scitula.....	46	nest.....	132
serrata.....	31	oviposition.....	132
speciosa.....	41	prey.....	132
tenuicornis.....	47	provisioning of nest.....	132
tuberculata.....	34	Vespa.....	15
villosa.....	45	vespiformis, Bembex.....	18
sulfurea, Steniolia.....	9	viduata, Bembidula.....	69
tenuicornis, Monedula.....	47	Bicyrtes.....	69
Stictiella.....	47	villosa, Monedula.....	45
texana, Bembex.....	111	Stictiella.....	45
Bembix.....	111		

NORTH AMERICAN EARTHWORMS OF THE FAMILY LUMBRICIDAE IN THE COLLECTIONS OF THE UNITED STATES NATIONAL MUSEUM.

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INTRODUCTION.

The classification of earthworms in common use at the present time recognizes four families of which three are represented in North America. The present paper deals with the family Lumbricidae, which is chiefly represented in Europe and Western Asia where it presumably originated. North America has scarcely a dozen indigenous species of this family as yet described and but a slightly larger number of species that are also found in the Eurasian region. A considerable number of the latter have probably been introduced into North America through the agency of European settlers. The earthworms which are most characteristic of the North American region belong to the families Megascolecidae and Geoscolecidae and will be dealt with in a subsequent paper.

The systematic literature on North American Lumbricidae is decidedly meager. Eisen was the pioneer in this field, and in 1874 listed nine species of which four were described as new. These species were recorded as from Mount Lebanon, New England, and from Niagara, Canada. Correspondence with Doctor Eisen has brought out the fact that the Mount Lebanon mentioned is really in the eastern part of the State of New York. Michaelsen described two new species from Georgia and Florida in 1894 and one from North Carolina in 1910, and in 1900 published an important paper dealing with the distribution and relationships of the lumbricid fauna of North America. Ude described a new species from Georgia in 1895, and H. F. Moore in the same year described a new species from Pennsylvania for which he had in 1893 described the new genus *Bimastos*. Finally, Smith and Gittins described two new Illinois species in 1915, and in the same year Smith published the description of a new variety together with a list of the species found in Illinois.

The Lumbricidae in the collection of the United States National Museum fortunately include specimens presented by Eisen from the original collections on which he based his descriptions of three of the new species mentioned above. These permit a description of the internal anatomy, of which a lack of knowledge had left their actual relationships in doubt.

This paper forms No. 70 of the series of contributions from the zoological laboratory of the University of Illinois.

TERMINOLOGY.

There is much lack of uniformity in the use of terms and symbols in publications dealing with earthworms, and hence it is desirable to explain some of those used in this paper. Those adopted are the simplest which are sanctioned by the usage of the more careful recent writers of systematic papers on the group.

Arabic numerals are used to designate the number of a somite, counting from the anterior end. When the separation between somites is obscure, advantage may be taken of the fact that the first setae are borne on the second somite. Externally the limits of somites are ordinarily indicated by transverse (intersegmental) grooves, while internally the septa serve this purpose. Not infrequently, and especially in the anterior part of the worm, there is a considerable lack of correspondence in the external and internal boundaries of somites thus indicated. Septa and intersegmental grooves for any two adjacent somites are represented by the same formula—for example, $5/6$ —the context showing which is meant. In the Lumbricidae there are eight setae to the somite, and these are more commonly arranged in pairs. It is customary to indicate the setae of either side by the use of the letters *a*, *b*, *c*, and *d*; the ventralmost seta being designated by *a*, the next by *b*, the next by *c*, and the dorsalmost one by *d*. If the distances *ab* and *cd* are less than one-third of the distance *bc*, the setae are said to be closely paired; and if otherwise, they are widely paired, or they may be unpaired or separate. If the prostomium completely divides the peristomium and the longitudinal grooves which form its lateral boundaries extend clear to the intersegmental groove $1/2$, the prostomium is said to be tanylobic. If the prostomium and its lateral grooves extend only part way across the peristomium and fail to reach the groove $1/2$, it is called epilobic. Tubercula pubertatis are glandular ridges closely associated with the ventral edges of the clitellum on some of its somites.

The spermathecae are pouches which open to the exterior and receive sperm cells from another individual. They are the same as the seminal receptacles mentioned in many textbooks. The sperm sacs open into the cavity of 10 or 11 and store temporarily the sperm

cells produced in those somites. Each sperm sac lies in a somite adjacent to the one into which it opens. These organs are often called seminal vesicles in the textbooks.

In the following key marginal numbers in parentheses refer to other paragraphs in the key which contain alternative statements which are to be compared with the one concerned and a decision made between them.

TECHNIC.

An adequate study of earthworms for systematic purposes demands serial sections of sexually mature specimens, although much important information can be gained from careful dissections.

When there is scarcity of material and in dealing with types, the writer, beginning at the anterior end and using a safety razor blade, splits the specimen in the sagittal plane as far as desired and at least through the 16th somite. A piece on one side of this cut is removed and made into serial sagittal sections. If there is dirt in the alimentary tract in the piece to be cut, it must be removed before imbedding. One is less likely to lose sections at the end of the series if he begins sectioning on the side opposite the cut surface.

KEY TO SPECIES OF LUMBRICIDAE REPORTED IN NORTH AMERICA.

- 1 (41) Prostomium incompletely divides the peristomium, epilobic2.
- 2 (40) Spermaries and spermiducal funnels not inclosed in sperm vesicles. (Anterior margin of clitellum is anterior to 30 in species included in this key.) *Helodrilus*.3.
- 3 (17) Spermathecal pores, dorsal to seta line *d*, near mid-dorsum4.
- 4 (9) Posterior margin of clitellum not extending as far as 29; antero-dorsal surface of body pigmented with some shade of brown. Amphibious. Subgenus *Eiseniella*.5.
- 5 (6) (7) (8) Spermiducal pores on 13; clitellum on 22 or 23-26 or 27.
H. (E.) tetraedrus typica.
- 6 (5) (7) (8) Spermiducal pores on 15; clitellum on 22 or 23-27.
H. (E.) tetraedrus hercynia.
- 7 (5) (6) (8) Spermiducal pores on 13; clitellum on 20 or 21-24 or 25.
H. (E.) tetraedrus neapolitana.
- 8 (5) (6) (7) Spermiducal pores on 15; clitellum on 20 or 21-24 or 25.
H. (E.) tetraedrus ninnii.
- 9 (4) Clitellum extending posteriorly at least to 29.....Subgenus *Eisenia*.10.
- 10 (11) Setae widely paired; *ab:bc:cd=5:9:5**H. (E.) venetus hortensis*.
- 11 (10) Setae closely paired12.
- 12 (13) Three pairs of spermathecal pores, 8/9, 9/10, and 10/11; clitellum, 24-30.
H. (E.) lönnbergi.
- 13 (12) Two pairs of spermathecal pores14.
- 14 (15) (16) Clitellum, 24-31; tubercula pubertatis, 27-29....*H. (E.) carolinensis*.
- 15 (14) (16) Clitellum, 24, 25 or 26-32; transversely banded with brown and buff.
H. (E.) foetidus.
- 16 (14) (15) Clitellum, 24, 25 or 26-31, 32 or 33; tubercula pubertatis, 29-31; without pigment.....*H. (E.) roseus*.
- 17 (3) Spermathecal pores, when present, in or ventral to seta line *d*18.
- 18 (22) (25) Four pairs of sperm sacs in 9-12; spermathecae present; setae closely pairedSubgenus *Allolobophora*.19.

- 19 (20) (21) Clitellum, 27 or 28-34 or 35; tubercula pubertatis, 31 and 33 or 31-33.
H. (A.) caliginosus or var.
 20 (19) (21) Clitellum, 27 or 28-35; tubercula pubertatis, 32-34 *H. (A.) longus*.
 21 (19) (20) Clitellum, 29-37; tubercula pubertatis on 31, 33, and 35. *H. (A.) chloroticus*.
 22 (18) (25) Three pairs of sperm sacs in 9, 11, and 12; spermathecae present; setae of North American species widely paired or separate Subgenus *Dendrobaena*. 23.
 23 (24) Clitellum, 27, 28, or 29-33 or 34; tubercula pubertatis, 31-33. *H. (D.) octaedrus*.
 24 (23) Clitellum, 25 or 26-31 or 32; tubercula pubertatis, 28-30. *H. (D.) subrubicundus*.
 25 (18) (22) Two pairs of sperm sacs in 11 and 12; spermathecae absent (sometimes imperfectly developed in *H. tenuis*) Subgenus *Bimastus* 26.
 26 (39) Setae more or less closely paired 27.
 27 (28) (35) Clitellum, 23-28; large chamber at end of sperm duct. *H. (B.) palustris*.
 28 (27) (35) Clitellum, otherwise but including less than ten somites 29.
 29 (32) Anterior margin of clitellum, anterior to 23 30.
 30 (31) Clitellum on 22-29; *ab* equal to *cd* *H. (B.) tumidus*.
 31 (30) Clitellum, beginning at 20-22; *ab* greater than *cd*
H. (B.) gieseleri and var. *hempeli*.
 32 (29) Anterior margin of clitellum on 24 or 25 33.
 33 (34) Clitellum, 24-30 *H. (B.) parvus*.
 34 (33) Clitellum, 24 or 25-31 *H. (B.) beddardi*.
 35 (27) (28) Clitellum including 10 somites or more 36.
 36 (37) (38) Clitellum, 23-32 or 24-33 *H. (B.) longicinctus*.
 37 (36) (38) Clitellum, § 25-35 *H. (B.) weichi*.
 38 (36) (37) Clitellum, 27-37 *H. (B.) zeteki*.
 39 (26) Setae, widely paired; clitellum, 26-31 or 32 *H. (B.) tenuis*.
 40 (2) Spermaries and spermiducal funnels inclosed in sperm vesicles; clitellum, 30-35; tubercula pubertatis, 31-34; setae separate or widely paired. *Octolasion lacteum*.
 41 (1) Prostomium completely divides the peristomium, tanylobic; spermaries and spermiducal funnels inclosed in sperm vesicles; sperm sacs in 9, 11, and 12.
Lumbricus. 42.
 42 (43) (44) Clitellum, 26 or 27-32; tubercula pubertatis 28-31 *L. rubellus*.
 43 (42) (44) Clitellum, 28-33; tubercula pubertatis, 29-32 *L. castaneus*.
 44 (42) (43) Clitellum, 31 or 32-37; tubercula pubertatis, 33-36 *L. terrestris*.
Lumbricus festivus (Savigny), clitellum, 34-39, has been reported in Canada by Stafford (1902).

Family LUMBRICIDAE.

Earthworms of this family have but eight setae to each somite. The anterior border of the clitellum is posterior to the spermiducal pores which in the great majority of species are on somite 15 but in a few, are one to three somites further anterior. A calciferous gland is present in the region of the gonads and a gizzard at the anterior end of the intestine. There are no typical prostate glands extending freely into the coelomic cavity. As in the great majority of earthworms, the spermaries and spermiducal funnels are in 10 and 11 and the ovaries in 13 and oviducal pores in 14.

A satisfactory grouping of the species of this family into genera and subgenera has proven to be extremely difficult. Michaelsen has recently (1910) discussed these difficulties and has reduced the number of genera to three—*Helodrilus*, *Octolasion*, and *Lumbricus*. *Helodrilus* includes the great majority of the species of the

family and is tentatively subdivided by Michaelsen into six sub-families, not very sharply defined, of which five are represented in North America.

Genus HELODRILUS Hoffmeister, 1845.

The chief character, by which species of this genus are distinguished, is the absence of any special sperm vesicles enclosing the spermaries and spermiducal funnels.

Subgenus EISENIELLA Michaelsen, 1900.

For synonymy see Michaelsen (1900a: 471).

Michaelsen (1910) has reduced this group from generic to sub-generic rank and considered its relationships to the subgenus *Eisenia* (Malm) to be so close as to hardly warrant their separation. The only character used as a basis for such separation is the somewhat shorter gizzard which is chiefly confined to the 17th somite in *Eiseniella* and ordinarily involves, in addition, more of the 18th somite in others. A much more significant character is probably to be found in the position of the oviducal pores. My study of American material of *Helodrilus tetraedrus* f. *typica*, *H. t. f. hercynia*, and Eisen's *Tetragonurus pupa* has shown in every specimen examined, the oviducal pores opening slightly mesad of *a* instead of slightly dorsad of *b*; where, as far as known, they open in all other Lumbricidae. If similar relations are found in European material, as is probable, the retention of the subgenus will be on a much better basis.

Eiseniella differs from the other subgenera, except *Eisenia*, in having the pores of the paired spermathecæ between the seta line *d* and the mid-dorsal line.

HELODRILUS (EISENIELLA) TETRAEDRUS (Savigny) forma TYPICA.

Enterion tetraedrum SAVIGNY, 1826: 184.

Allurus tetraedrus EISEN, 1874: 54.

Eiseniella tetraedra (*typica*) MICHAELSEN, 1900a: 472.

Helodrilus (*Eiseniella*) *tetraedrus* forma *typica* MICHAELSEN, 1910: 11.

For more complete synonymy of this and other species, see Michaelsen, 1900a.

Length, 3–6 cm. Somites, 70–90. Color, quite variable, but usually some shade of brown. Prostomium usually epilobic. Setae paired; slightly posterior to clitellum, *aa*: *ab*: *bc*: *cd*: *dd* = 3: 1: 3: 1: 6; near posterior end, *aa*: *ab*: *bc*: *cd*: *dd* = 5: 2: 5: 2: 6–8. Clitellum on 22 or 23–26 or 27. Tubercula pubertatis on 23–25 or 26. First dorsal pore on 4/5. Spermiducal pores on 13. Oviducal pores on 14, slightly mesad of *a*. Spermathecal pores on 9/10 and 10/11 between *d* and mid-dorsal line. Septa, 7/8–11/12 slightly thickened. Longitudinal partitions of the calciferous gland, narrow and the

entire gland poorly developed as compared with those of many lumbricid species. Sperm sacs in 9-12. Spermathecae on dorsal side, chiefly in septa 9/10 and 10/11. This position of the spermathecal pores is the more usual one and is stated by Cognetti (1905) to be the normal one in European specimens. It differs from the statements of Rosa (1893), Michaelsen (1900a), and of Smith (1915).

H. tetraedrus f. *typica* finds favorable conditions in the water-soaked banks of streams, lakes, and ponds. It is distributed generally throughout Europe and in many parts of the world where Europeans have settled. In the United States it has been reported from Pennsylvania and California.

New localities: Ohio, Michigan, Indiana, Illinois, Colorado, and Washington (Puget Sound region).

HELODRILUS TETRAEDRUS forma HERCYNIA (Michaelsen).

Allurus hercynius MICHAELSEN, 1890: 7.

Eiseniella tetraedra hercynia MICHAELSEN, 1900a: 473.

Helodrilus (*Eiseniella*) *tetraedrus* f. *hercynia* MICHAELSEN, 1910: 11.

Similar to f. *typica* except that the spermiducal pores are on 15 instead of 13.

The habitat is the same as that of f. *typica*, but the reported distribution is less extensive, being limited to parts of Europe, and in the United States to California.

New locality: It is abundant at Urbana, Illinois, in association with f. *typica*.

HELODRILUS TETRAEDRUS forma NEAPOLITANA (Örley).

Allurus neapolitanus ÖRLEY, 1885: 12.

Eiseniella tetraedra neapolitana MICHAELSEN, 1900a: 473.

Very similar to f. *typica* in most respects, but differs in the following: Length (maximum), 8 cm.; somites (maximum), 150; clitellum on 20 or 21-24 or 25; tubercula pubertatis on 21-24 or 24. The spermiducal pores are on 13 as in the typical form.

Forma *neapolitana* is known from Italy and from California.

HELODRILUS TETRAEDRUS forma NINNII (Rosa).

Allolobophora ninnii ROSA, 1886: 680.

Allurus ninnii MICHAELSEN, 1890: 10.

Eiseniella tetraedra ninnii MICHAELSEN, 1900a: 473.

Similar to f. *typica*, but differs in the following respects: Somites, 120-130; clitellum on 20 or 21-24 or 25; tubercula pubertatis on 21 or 22-24; spermiducal pores on 15.

The chief difference between this form and f. *neapolitana* is in the position of the spermiducal pores.

Forma *ninnii* has been reported from Italy, Western Asia, and California.

NOTE ON TETRAGONURUS Eisen.

Tetragonurus pupa EISEN, 1874a: 47.

Allurus pupa MICHAELSEN, 1890: 10.

Eiseniella tetraedra pupa MICHAELSEN, 1900a: 474.

Length, about 2.5 cm. Somites, about 40. Color, sienna-brown anteriorly; light red posteriorly. Prostomium not dividing the peristomium. Setae paired. Clitellum on 18–22. Tubercula pubertatis on 19–21. Spermiducal pores on 12.

In 1874 Eisen briefly described, in substance as above, the external characters of specimens collected by him at Niagara. He referred to their resemblance in appearance and habits to *Helodrilus tetraedrus*, then known as of the genus *Allurus*. In his paper there is no reference to their abundance. One of the specimens was presented to the United States National Museum and has afforded an opportunity for a more extended examination, including a study of the internal anatomy from sagittal sections made from one half of the anterior part of the worm. Some of the more important characters have already been announced in a brief note in *Science* (1914: 364). The following are the important anatomical characters:

Somites, 41. Clitellum on 18–22. Tubercula pubertatis on 19–21. Spermiducal pores on 11, between *b* and *c*. Oviducal pores on 10, slightly mesad of *a*. Spermathecal pores in 5/6 and 6/7, and dorsad of *d*. Evaginations at anterior end of calciferous gland in 6. Crop in 11 and 12. Gizzard in 13 and a little way into 14. But one pair of hearts, which are in 7. Spermaries and spermiducal funnels in 6 and 7. Ovaries and oviducal funnels in 9. Sperm sacs in 7 and 8; none found in 5 and 6. Spermathecae in 6 and 7; adherent to the septa, 5/6 and 6/7.

There is no satisfactory explanation for the discrepancy in the position of the spermiducal pores. It may have been due to an error in counting, or possibly there may have been a specimen in which they actually were on 12.

It is obvious that each of the locations described for these organs is four somites anterior to the position normal in Lumbricidae. We have merely to assume that a specimen of *H. tetraedrus* f. *hercynia* had suffered the loss of the anterior nine somites and regenerated the usual number of five new ones, and the result would be such a worm as we have under discussion. It is the belief of the writer that the specimen originated in some such way. Such an assumption of course raises the question of the number of specimens collected and the possibility of examining others of the same collection.

In reply to a letter asking for further information, Doctor Eisen makes the following statements:

Tetragonurus pupa, I found in all, if I remember correctly, three specimens. They all agreed or seemed to agree; and the one you have sectioned should in my opinion,

or so I thought, be the type. The place where I collected the *T. pupa* was on the American side of the falls just below the suspension bridge (Niagara).

In view of the above facts, there seems insufficient reason for regarding this form as entitled to a distinct systematic position.

Subgenus *EISENIA* Malm, 1877.

The location of the spermathecal pores near the mid-dorsal line, or at least dorsad of *d*, separates this subgenus from others except *Eiseniella*; from which it is distinguished by the extent of the gizzard and probably by the position of the oviducal pores, as stated in the description of the subgenus *Eiseniella*.

HELODRILUS (EISENIA) LÖNNBERGI (Michaelsen).

Allolobophora lönnbergi MICHAELSEN, 1894: 179.

Eisenia lönnbergi MICHAELSEN, 1900a: 475.

Length, 9.6 cm. Somites, 138. Color of dorsal and lateral surfaces, brownish violet; the pigment lacking on the lateral surfaces of 8–12. Prostomium, epilobic $\frac{3}{4}$. Setae, closely paired and ornamented; those of the ventral pairs on most clitellar somites modified into long slender sexual setae; anteriorly, *dd* is somewhat less than $\frac{1}{2}$ of the circumference and posteriorly only $\frac{3}{4}$ of it. Clitellum on 24–30. Tubercula pubertatis on 26–29. First dorsal pore on 7/8. Spermiducal pores on 15 without definite glandular elevations surrounding them; each is dorsal to *b* and at a distance equal to about *2ab*. Oviducal pores on 14, slightly dorsad of *b*. Spermathecal pores on 8/9–10/11, close to the dorsal median line and near the dorsal pores. Septum 12/13, slightly; and septa 13/14 and 14/15, somewhat more strongly thickened. Sperm sacs in 9, 11, and 12. Spermathecae in 9, 10, and 11.

H. lönnbergi has been reported from Georgia and North Carolina.

HELODRILUS (EISENIA) CAROLINENSIS (Michaelsen)

Eisenia carolinensis nomen nudum, MICHAELSEN, 1903: 137.

Helodrilus (Eisenia) carolinensis MICHAELSEN, 1910: 15.

Length, 3.5 cm. Somites, 121. Color, more or less reddish, due in part to weak red pigmentation of dorsal surface. Prostomium, epilobic $\frac{3}{4}$. Setae, closely paired; posterior to the clitellum, *aa*: *bc*: *dd* = 4 : 3 : 6; anteriorly *dd* = $\frac{1}{2}$ circumference. Clitellum on 24–31. Tubercula pubertatis on 27–29, slightly dorsad of seta line *b*. Papillae include ventral setae of 10, 16, 17, 24 or 25–31. First dorsal pore on 5/6. Spermiducal pores on 15. Spermathecal pores in 9/10 and 10–11, close beside the mid-dorsal line. Septa of anterior somites including the gizzard region are slightly thickened. Sperm sacs in 9, 11, and 12; those of 9 smaller than the others. Spermathecae in 10 and 11.

One specimen introduced with plants into Hamburg from Fayetteville, North Carolina.

HELODRILUS (EISENIA) FOETIDUS (Savigny).

Enterion foetidum (corr. *foetidum*) SAVIGNY, 1826: 182.

Allolobophora foetida EISEN, 1874: 50.

Eisenia foetida MALM, 1877: 45.

Helodrilus (*Eisenia*) *foetidus* MICHAELSEN, 1910: 16.

Length, 6–13 cm. Somites, 80–110. Color, conspicuous, due to the transverse purple or brown bands on the middle of the somites alternating with nearly pigmentless intersegmental areas; pigment lacking on the lateral surfaces of 9–11. Prostomium, epilobic $\frac{1}{2}$. Setae closely paired. Clitellum on 24, 25, or 26–32. Tubercula pubertatis on 28–30 or 31. First dorsal pore on 4/5. Spermiducal pores on 15, between *b* and *c* and not very near to either. Oviducal pores on 14, slightly dorsad of *b*. Spermathecal pores on 9/10 and 10/11, near the mid-dorsal line. Septa of anterior somites not much thickened, those of 7/8–9/10, 13/14, and 14/15 most so but only very moderately. Sperm sacs in 9–12, those of 9 and 10 smaller than the others. Spermathecae more commonly in 9 and 10, but always in close relation to the septa 9/10 and 10/11, and sometimes one or both may lie posterior to them.

H. foetidus finds very favorable conditions in manure and compost heaps and is often found in decaying logs. It is abundant throughout Europe and in various parts of the world where Europeans have settled. In North America it is abundant and very widely distributed. It has been collected in most of the States where earthworms have been collected, including those of the Atlantic and Pacific coasts, the Mississippi Valley, the Rocky Mountain region, and the Gulf States.

HELODRILUS (EISENIA) ROSEUS (Savigny).

Enterion roseum SAVIGNY, 1826: 182.

Allolobophora rosea ROSA, 1893: 427.

Eisenia rosea MICHAELSEN, 1900a: 478.

Helodrilus (*Eisenia*) *roseus* MICHAELSEN, 1910: 14.

Allolobophora mucosa EISEN, 1874: 47.

Length, 3–8 cm. Somites, 120–150. Color of living specimens, pale red, but the body walls are without definite pigment. Prostomium, epilobic $\frac{1}{2}$. Setae closely paired. Clitellum usually includes 25–32 and occasionally involves 24 or 33. Tubercula pubertatis, usually on 29–31, occasionally 30–31. Glandular papillae often include one or more setal bundles of 9, 10, 12, or 13, which may have modified genital setae. First dorsal pore on 4/5. Spermiducal pores on 15 and nearer to *b* than to *c*. Oviducal pores on 14, just dorsad of *b*. Spermathecal pores on 9/10 and 10/11, close

to the mid-dorsal line. Septa 6/7-9/10, considerably thickened; others to 14/15, but slightly. Sperm sacs in 9-12. Spermathecae on dorsal side of 10 and 11 with but short ducts.

H. roseus is widely distributed in Europe and in various parts of the world where Europeans have settled. In the United States it has been reported from New York, Georgia, Indiana, Illinois, Louisiana, Arizona, and California. New locality: Maine.

HELODRILUS (EISENIA) VENETUS var. HORTENSIS.

Allolobophora subrubicunda forma *hortensis* MICHAELSEN, 1890: 15.

Allolobophora veneta hortensis ROSA, 1893: 429.

Eisenia veneta var. *hortensis* MICHAELSEN, 1900a: 477.

Helodrilus (Eisenia) venetus var. *hortensis* MICHAELSEN, 1910: 30.

Length, 3.5-5 cm. Somites, 80-120. Setae, widely paired; posterior to the clitellum, $ab:bc:cd = 5:9:5$. Clitellum on 24, 25, 26, or 27-32 or 33. Tubercula pubertatis, two pair on 30 and 31. First dorsal pore on 5/6. Spermiducal pores on 15. Spermathecal pores on 9/10 and 10/11, close to the dorsal median line. Sperm sacs in 9, 11, and 12.

H. venetus hortensis has been reported from various parts of Europe and from southern Africa and South America. The only record from North America is that of Michaelsen (1900:12), of specimens collected by Doctor Eisen at San Francisco, California.

Subgenus ALLOLOBOPHORA Eisen, 1874.

Setae more or less closely paired. Sperm sacs, four pairs in 9-12; those of 10 approximately as large as those of 9.

HELODRILUS (ALLOLOBOPHORA) CALIGINOSUS (Savigny) f. TYPICA and f. TRAPEZOIDES (Dugès).

Enterion caliginosum SAVIGNY, 1826: 180.

Allolobophora caliginosa ROSA, 1893: 442.

Helodrilus (Allolobophora) caliginosus MICHAELSEN, 1900a: 482.

Allolobophora turgida EISEN, 1874: 46.

Allolobophora turgida forma *tuberculata* EISEN, 1874a: 43.

Lumbricus trapezoides DUGÈS, 1828: 289.

Helodrilus (Allolobophora) caliginosus trapezoides MICHAELSEN, 1900a: 483.

Length, very variable, 6-17 cm. Somites, 105-240. Color of antero-dorsal surface, brown-red; very variable in intensity in different specimens. Prostomium, epilobic. Setae very closely paired, especially those of the lateral pairs. Clitellum on 27-34 or 35. Tubercula pubertatis in f. *typica* on 31 and 33 and in f. *trapezoides* on 31-33. (The latter is by far the most common in North America.) Conspicuous glandular papillae surround the ventral setae of 9, 10, and 11 and in the clitellar region are very constantly present on 32-34 and less certainly on 28 and 30. First dorsal pore, usually at 9/10. Spermiducal pores on 15, rather more than half

way from *b* to *c*. Oviducal pores on 14, slightly dorsad of *b*. Spermathecal pores on 9/10 and 10/11, in line with dorsal bundles. Septa 6/7–9/10, strongly thickened and 5/6 and 11/12–14/15, a little less so. Longitudinal partitions of the calciferous gland, usually 55–65 in number. Sperm sacs in 9–12. Spermathecae included within the septa 9/10 and 10/11 and not extending freely into the somite cavities.

This is a species of the soil but seems to thrive equally well in the undisturbed soil of woodlands and in that of cultivated fields and gardens. It also abounds in the bottom lands of our rivers.

H. caliginosus trapezoides is apparently the most abundantly represented and certainly the most generally distributed of the North American species of earthworms. There is scarcely one of the United States in which collections have been made in which this species is not found abundantly represented.

HELODRILUS (ALLOLOBOPHORA) LONGUS (Ude).

Enterion terrestre SAVIGNY, 1826: 180.

Allolobophora terrestris ROSA, 1893: 444.

Allolobophora longa UDE, 1885: 136.

Helodrilus (*Allolobophora*) *longus* MICHAELSEN, 1900a: 483.

Length, 12–16 cm. Somites, 160–200. Prostomium, epilobic $\frac{1}{2}$. Setae closely paired. Clitellum on 27 or 28–35. Tubercula pubertatis on 32–34. First dorsal pore on 12/13. Spermiducal pores on 15, between *b* and *c*. Oviducal pores on 14, slightly dorsad of *b*. Spermathecal pores on 9/10 and 10/11, in the seta line *c*. Septa 6/7–8/9 strongly thickened; thickness decreases posteriorly from 8/9. Sperm sacs in 9–12. Spermathecae in 10 and 11, enclosed in sacs between anterior septum and body wall.

H. longus has been reported from Grand Manan and from Indiana. It is also found in many parts of Europe.

New localities: Maine and Canada (Toronto).

HELODRILUS (ALLOLOBOPHORA) CHLOROTICUS (Savigny).

Enterion chloroticum + *E. virescens* SAVIGNY, 1826: 183.

Allolobophora chlorotica VEJDovsky, 1884: 60.

Helodrilus (*Allolobophora*) *chloroticus* MICHAELSEN, 1900a: 486.

Lumbricus riparius HOFFMEISTER, 1843: 189.

Allolobophora riparia EISEN, 1874: 46.

Length, 5–7 cm. Somites, 80–125. Color of American specimens, more or less greenish. Prostomium, epilobic. Setae, closely paired. Clitellum on 29–37. Tubercula pubertatis, three pairs of sucker-like elevations on 31, 33, and 35. First dorsal pore on 4/5. Spermiducal pores on 15, between *b* and *c*. Oviducal pores on 14, slightly dorsad of *b*. Spermathecal pores on 8/9–10/11, in line with dorsal bundles. Septa 6/7–13/14, moderately thickened; those from 9/10 diminishing gradually toward the posterior. Sperm sacs in 9–12.

Spermathecae in 9, 10, and 11, extending freely into the somite cavities with ducts of moderate length.

H. chloroticus is widely distributed in Europe and in various parts of the world where Europeans have settled. In North America it has been reported from Greenland, North Carolina, Vancouver, California, Mexico, and Guatemala.

New localities: District of Columbia, Indiana, and Colorado.

Subgenus DENDROBAENA (Eisen), 1874.

The following characters are common to the more typical members of this subgenus: Setae, widely paired or separate. Spermathecal pores on 9/10 and 10/11, in the setae lines *c* or *d*. Three pairs of sperm sacs in 9, 11, and 12.

There are species that combine some of these characters with others belonging to other subgenera, and thus break down the dividing lines and make the classification difficult.

HELODRILUS (DENDROBAENA) OCTAEDRUS (Savigny).

Enterion octaedrum SAVIGNY, 1826: 183.

Allolobophora octaedra ROSA, 1887: 2.

Helodrilus (Dendrobaena) octaedrus MICHAELSEN, 1900a: 494.

Dendrobaena boeckii EISEN, 1874: 53.

Length, 2.5–4 cm. Somites, 80–95. Color, violet-brown. Prostomium, epilobic. Setal intervals *aa*, *ab*, *bc*, and *cd* approximately equal; *dd* somewhat greater than either. Clitellum on 27, 28, or 29–33 or 34. Tubercula pubertatis on 31–33. First dorsal pore on 4/5. Spermiducal pores on 15, between *b* and *c*. Oviducal pores on 14, slightly dorsad from *b*. Spermathecal pores on 9/10–11/12, in the seta line *d*. Septa all thin with a slight thickening of 13/14 and 14/15. Sperm sacs in 9, 11, and 12. Spermathecae usually in 9, 10, and 11, but occasionally one or more may be found in the somites next posterior.

H. octaedrus is known from various parts of Europe, northern Asia, Iceland, and Greenland. In North America it has been reported from Newfoundland and Mexico.

New locality: Colorado (Boulder).

HELODRILUS (DENDROBAENA) SUBRUBICUNDUS (Eisen).

Allolobophora subrubicunda EISEN, 1874: 51.

Helodrilus (Dendrobaena) rubidus, var. *subrubicunda* MICHAELSEN, 1900a: 490.

Helodrilus (Dendrobaena) subrubicundus MICHAELSEN, 1910: 52.

Length, 4–7.5 cm. Somites, 60–110; usually nearer the upper limit. Color of antero-dorsal surface, more or less red. Prostomium, epilobic $\frac{3}{4}$. Setae, widely paired; *bc:cd:dd* = 2:1:4; *cd*, is a little greater than *ab*. Clitellum on 26–31, occasionally invading 25 or 32.

Tubercula pubertatis on 28–30. First dorsal pore on 5/6. Spermiducal pores on 15, between *b* and *c*. Oviducal pores on 14, slightly dorsad of *b*. Spermathecal pores on 9/10 and 10/11, in the seta line *c*. Septa 7/8 and 8/9 moderately thickened, 6/7, 9/10, 13/14, and 14/15 slightly thickened. Sperm sacs in 9, 11, and 12. Spermathecae in 9 and 10, free in somite cavities, with very short ducts which enter the septa near the body wall.

Specimens collected in Illinois have been found in wet soil more or less subject to sewage contamination.

H. subrubicundus is widely distributed in Europe and in various parts of the world where Europeans have settled. It has been reported in North America from Newfoundland and California.

New localities: Illinois, Colorado, and Canada (Niagara).

Subgenus BIMASTUS (H. F. Moore), 1893.

This subgenus includes a group of species, chiefly North American, which have in common the following characters: Tubercula pubertatis are indistinct or more commonly lacking. There are but two pairs of sperm sacs and these are in 11 and 12. Normally developed spermathecae are lacking. In most species the clitellum does not extend posterior to 32.

HELODRILUS (BIMASTUS) PALUSTRIS (H. F. Moore).

Bimastos H. F. MOORE, 1893: 333.

Bimastos palustris H. F. MOORE, 1895: 473.

Allolobophora (*Bimastos*) *palustris* MICHAELSEN, 1900: 10.

Helodrilus (*Bimastos*) *palustris* MICHAELSEN, 1900a: 502.

Length, in life, reaches 7.5 cm. Somites, 80–100. Color, pale red, but not due to pigment. Prostomium, epilobic $\frac{1}{2}$. Setae closely paired; posterior to clitellum, *aa:ab:bc:cd:dd* = 18:4:16:3:27; ventral setae of 13 and 16, provided with special glands. Clitellum on 23–28. Tubercula pubertatis, lacking. First dorsal pore on 5/6. Spermiducal pores at summits of large chambers, formed by invaginations of body wall of posterior part of 15, between seta lines *b* and *c*; external openings of these chambers, surrounded by prominent glandular masses. Oviducal pores on 14, slightly dorsad and posteriad of *b*. Septa scarcely thickened. Chambers at anterior end of calciferous gland open into the esophagus in 10; longitudinal partitions of the gland about 45 in number. Sperm sacs in 11 and 12. Spermathecae lacking.

H. palustris is found in the wet earth of the shores of rivers and ponds. It has been collected in Pennsylvania, New Jersey, and North Carolina.

HELODRILUS (BIMASTUS) TUMIDUS (Eisen).

Allolobophora tumida EISEN, 1874a: 45.

Allolobophora (Bimastus) tumida MICHAELSEN, 1900: 10.

Helodrilus (Bimastus) tumidus MICHAELSEN, 1900a: 502.

Length, about 3 cm. Somites, 40–50. Color, reddish-brown. Prostomium, epilobic $\frac{1}{4}$. Setae, closely paired. Clitellum on 22–29. Tubercula pubertatis on 27 and 28; inconspicuous. Spermiducal pores on 15, with small but definite glandular elevations.

The description of this species by Eisen is in substance as above and is accompanied by four figures (1874a, fig. 5–8) showing, respectively: The dorsal aspect of the worm, natural size; ventral aspect of the clitellar region with the tubercular pubertatis; an outline sketch showing the shape of the body in cross section and the relations of the setae; and a drawing of the superficial aspects of the posterior two somites.

One specimen of the original collection was presented by Eisen to the United States National Museum, and has given an opportunity to study the internal anatomy and to make comparisons with closely related species. There is no indication of the number of specimens collected. In some respects the correspondence of Eisen's figures and description with the museum specimen is so close that it seems fairly probable that they were based, at least in part, on that particular worm.

The specimen is strongly contracted and measures 1.8 cm. in length. Eisen's figure (natural size) shows a length of 2 cm. His statement "longitudo circiter 30 mm." was probably based on living specimens. The maximum diameter is .25 cm. The number of somites is 48, while Eisen gives "circiter 40" in his description and 50 in his table which lists characters of several species. The appearance of the specimen suggests the probability that it is incomplete; and this may account for the fact to which he calls attention—namely, that toward the posterior, from and including the clitellum, the somites gradually increase in length up to the last somite, which is almost twice as long as the one next preceding. It seems to me fairly probable that the last somite is really just at the beginning of regeneration of more somites, but I have no positive evidence to that effect.

The setae are closely paired, but the intervals are not as figured by Eisen. On somite 32, $aa:ab:bc:cd:dd=18:4:18:4:45$ represents very closely the relative setal distances. Toward the posterior, dd becomes less and ab and cd slightly greater, but nowhere is ab as small as figured by Eisen, who represents it as distinctly less than cd and only about $\frac{1}{4} aa$. Neither is dd as small as represented in the figure, where it is scarcely $\frac{1}{4} aa$. In the specimen examined, dd is at least 2 aa and near the clitellum is about $\frac{1}{2} aa$.

The clitellum is sharply defined at its anterior and posterior limits on 22 and 29, as described, but it has an uneven development and extends slightly ventrad of two rather thick patches on 27 and 28, which I assume to be the tubercula pubertatis which Eisen described and figured. They seem too far dorsad and too similar to the clitellar mass about them to be homologous with the tubercula pubertatis of typical Lumbricidae. They are dorsad of seta line *b*. The first dorsal pore is on 5/6. The spermiducal pores are on 15; dorsad of *b*, about $\frac{1}{2}$ *bc*. The oviducal pores are on 14, slightly dorsad of *b*.

The septa 6/7–9/10 are slightly thickened, 8/9 being somewhat thickest, and 13/14 and 14/15 are also slightly thickened and about equal to 8/9. The longitudinal partitions of the calciferous gland are apparently about 40 in number. The exact number can not be ascertained from longitudinal sections of one side. The last pair of hearts is in 11. Spermaries and spermiducal funnels are in 10 and 11 and present no peculiarities. The sperm sacs are in 11 and 12 and have the ordinary appearance and relations. Spermathecae are lacking.

In his general comment on this species, Eisen refers to the peculiar position of the setae which gives a rectangular appearance like that of *H. tetraedrus*, and states that it is very characteristic of this species. The specimen bears out his statement and also his figure, except as to the setal distances *ab* and *dd* mentioned above.

H. tumidus was found under moss and leaves in damp woods at Mount Lebanon, New York (New England of Eisen's paper). No other locality has been reported unless it should develop, that the species is identical with *H. gieseleri hempeli* Smith, described below.

HELODRILUS (BIMASTUS) GIESELERI (Ude) forma TYPICA.

Allolobophora gieseleri UDE, 1895: 127.

Allolobophora (Bimastus) gieseleri MICHAELSEN, 1900: 10.

Helodrilus (Bimastus) gieseleri MICHAELSEN, 1900a: 502.

Length, average 5.5 cm. Somites, about 110. Color of antero-dorsal part, faint red with bluish iridescence. Prostomium, epilobic $\frac{1}{2}$. Setae, closely paired; slightly posterior to the clitellum, *aa* : *bc* : *dd* = 10 : 9 : 26. Clitellum on 20– $\frac{1}{2}$ 30; saddle form, extending ventrally nearly to *b*. Tubercula pubertatis, lacking. First dorsal pore on 5/6. Spermiducal pores on 15; a little dorsad of *b*. Oviducal pores on 14; slightly dorsad of *b*. Septa 6/7–14/15, slightly thickened. "Hearts" in 7–11. Sperm sacs in 11 and 12. Spermathecae lacking.

The description is taken from Ude's paper which was based on a collection from Georgia. Specimens in the possession of the writer, which he assumes to belong to this species and which were collected in Florida by Mr. A. Hempel, agree very closely in most respects with Ude's description. The length is greater, 6–10 cm., but the

specimens were anesthetized before killing. In some of the specimens, the anterior margin of the clitellum is on 21 while in others it is on 20. aa is approximately $\frac{1}{4}bc$, and ab is greater than cd . There are about 40 longitudinal partitions in the calciferous gland.

HELODRILUS (BIMASTUS) GIESELERI var. HEMPELI Smith.

Helodrilus (Bimastus) gieseleri var. *hempeli* SMITH, 1915: 551.

Length, 5–8 cm. Somites, usually 105–115 in complete specimens. Color, brown-red, distributed fairly uniformly on the dorsal half of the worm; the ventral half is without pigment. Posterior to the clitellum, $aa : ab : bc : cd : dd = 20 : 4 : 16 : 3 : 52$, approximately. Clitellum, 22–29 or $\frac{1}{3}$ 30. Septa $\frac{6}{7}$, $\frac{7}{8}$, and $\frac{13}{14}$, slightly thicker than others, none much thickened. Longitudinal partitions of the calciferous gland, about 40 in number. Sperm sacs and spermathecae, as in the typical form.

These worms are ordinarily found under the bark of decaying logs or in the rotten wood. They are present in collections made in Florida (Monticello), Ohio, Illinois, Kansas, and Texas.

A comparison of the above description with that of *H. tumidus* will show their great similarity in most respects. The only significant differences are in the number of somites, the intervals between the setae, and the shape of the body as shown in cross section. We do not know how many specimens Eisen had as a basis for his statements concerning the number of somites in *H. tumidus*; "circiter 40," in the text; and 50, as given in the table. If there were several specimens, we can not safely assume that they were all mutilated and thus explain the presence of less than half the number of somites, normal to *H. gieseleri* and *H. g. hempeli*. The spacing of the setae in the setal bundles, ab and cd , is subject to much variation in the different bundles in the same worm, and it is quite possible to get formulae from adjacent somites that are materially different. Care is necessary to have the setal formula show average conditions. The specimen of *H. tumidus* shows almost exact equality between ab and cd , on the average. There is great uniformity in the relation of $ab =$ about $\frac{1}{3}cd$ in all of the *H. gieseleri* and *H. g. hempeli* material examined by the writer. The tetragonal form of the body is very noticeable in *H. tumidus*, as stated by Eisen. It is no more noticeable in the other forms under discussion than in the average Lumbricidae. It seems more reasonable to assume that this difference is due to structural conditions rather than to mere differences in methods of preservation. On the whole, it seems safer to await more complete knowledge of the earthworms of the region where *H. tumidus* was collected before uniting it with *H. gieseleri hempeli*. If such union is found desirable, then *H. gieseleri typica* would reasonably be treated as a variety of *H. tumidus*.

HELODRILUS (BIMASTUS) PARVUS (Eisen).*Allolobophora parva* EISEN, 1874a: 46.*Allolobophora (Bimastus) parva* MICHAELSEN, 1900: 10, 14.*Helodrilus (Bimastus) parvus* MICHAELSEN, 1900a: 502.

Length, 2.5–4 cm. Somites, 85–111. Color of antero-dorsal part, brown-red. Prostomium, epilobic $\frac{1}{2}$ – $\frac{3}{4}$. Setae closely paired; a little posterior to the clitellum, $aa : ab : bc : cd : dd = 18 : 4 : 16 : 3 : 48$. Clitellum on 24–30. Indefinite ridges (tubercula pubertatis?) on 25–29, occasionally beginning on 26 or reaching 30. First dorsal pore on 5/6. Spermiducal pores on 15, between *b* and *c*. Oviducal pores on 14, slightly dorsad of *b*. Septa 7/8 and 8/9, slightly thickened, others scarcely any. Longitudinal partitions of the calciferous gland, about 40 in number. Sperm sacs in 11 and 12. Spermathecae lacking.

H. parvus has been reported from New York, California, Louisiana, Mexico, and Guatemala in North America; and also from China, Japan, and Africa.

New localities: Michigan and Kansas.

HELODRILUS (BIMASTUS) BEDDARDI (Michaelsen).*Allolobophora beddardi* MICHAELSEN, 1894: 182.*Allolobophora (Bimastus) beddardi* MICHAELSEN, 1900: 10, 13.*Helodrilus (Bimastus) beddardi* MICHAELSEN, 1900a: 502.

Length, 1.7–6.5 cm. Somites, 66–97. Color, reddish antero-dorsally. Prostomium, epilobic $\frac{1}{2}$ – $\frac{3}{4}$. Setae, closely paired; $aa : ab : bc : cd : dd = 26 : 4 : 20 : 3 : 80$. Clitellum, usually on 24–31, but sometimes begins on 25 and often invades 32. Tubercula pubertatis(?) are indefinite ridges on 24 or 25–30. First dorsal pore on 5/6. Spermiducal pores on 15, between *b* and *c*. Oviducal pores on 14, slightly dorsad of *b*. Septa, all very thin. Longitudinal partitions of calciferous gland, about 40 in number. Sperm sacs in 11 and 12. Spermathecae are lacking.

Specimens of *H. beddardi* in the writer's collection were obtained from wet situations and in decaying logs, stumps, or moss. This species has been reported from Florida, California, and Washington and also from the Hawaiian Islands and Tibet.

New localities: Michigan, Illinois, and Montana.

The close resemblance of *H. parvus* and *H. beddardi* is apparent from the foregoing descriptions, and Michaelsen (1910: 64) has expressed doubt of their real distinctness. A careful comparison of the material available to the writer has convinced him that the species are actually distinct. This material consists of specimens of *H. parvus* from three States ranging from Michigan to California and of *H. beddardi* from four States ranging from Florida to Montana. In the latter species, the clitellum uniformly extends a little farther

posteriad; although the length is somewhat greater, the number of somites is less; the setae are more closely paired in the latter species; and there seems to be a constant difference in the shape of the anterior ends. In *H. beddardi*, the anterior somites are comparatively little smaller than the others, and the prostomium is broad and blunt, which all tend to give the anterior end a comparatively broad and blunt appearance. In *H. parvus*, the anterior somites are decidedly more reduced in diameter, and the end seems considerably more pointed. As far as can be judged from my data, *H. parvus* is found in higher and drier situations than is *H. beddardi*.

HELODRILUS (BIMASTUS) LONGICINCTUS Smith and Gittins.

Helodrilus (Bimastus) longicinctus SMITH and GITTINS, 1915: 548.

Length of well extended specimens, 6.5–9 cm. Somites, 98–122. Color of antero-dorsal part, rose-red; other parts distinctly paler. Prostomium, epilobic $\frac{1}{2}$ – $\frac{3}{4}$. Setae, closely paired; $aa : ab : bc : cd : dd$, = 10 : 1 : $7\frac{1}{2}$: $\frac{4}{5}$: 30. This formula represents the approximate relations both anterior and posterior to the clitellum, but some variations are found. Clitellum on 23–32 or 24–33, and the ventral edges extend no farther ventrad than *b*. Tubercula pubertatis are entirely lacking. First dorsal pore on 5/6. Spermiducal pores on 15, slightly dorsad of *b* and surrounded by a rather prominent glandular area which encroaches on 16. Oviducal pores on 14, slightly dorsad of *b*. Septa 6/7 and 14/15, somewhat thickened; and 7/8–13/14, more strongly thickened. Longitudinal partitions of the calciferous gland, about 60 in number. Last hearts in 11 and much smaller than those of 10. Sperm sacs in 11 and 12. Spermathecae are lacking.

H. longicinctus occurs abundantly in the soil of lawns, parkings, and near-by woodlands of Urbana, Illinois. This is the only locality from which it is thus far known.

HELODRILUS WELCHI, new species.

Length of alcoholic specimen, 13.5 cm. Diameter (maximum), .45 cm., at clitellum. Somites, 116. Color, no pigment except narrow transverse bands of brown flecks in the zone of the setae on each of the somites 5–15. Prostomium, epilobic. Setae, closely paired; on somite 45, $aa : ab : bc : cd : dd$ = 8 : 1 : 6 : $\frac{3}{4}$: 15. Clitellum, $\frac{1}{2}$ 25–35; pale flesh color. Tubercula pubertatis, lacking. First dorsal pore on 5/6. Spermiducal pores on 15, slightly dorsad of *b* and not conspicuous. Septa 8/9–11/12, very strongly thickened; 6/7, 7/8, 12/13, and 13/14, less strongly thickened; and 14/15, scarcely thickened. Longitudinal partitions of the calciferous gland, about 40 in number. Last hearts, in 11 and about equal to those of 10. Sperm sacs in 11 and 12. Spermathecae, lacking.

One specimen, collected near Manhattan, Kansas, by Dr. P. S. Welch April 2, 1914.

Holotype.—Cat. No. 16782, U.S.N.M.

The specimen was received in living condition. In normal locomotion it had a length, when extended, of 14 cm. Its diameter, anterior to the clitellum, was 0.5 cm. and posteriorly 0.4 cm. When strongly contracted the length was 8 cm. and the maximum diameter, 0.7 cm. The worm was very pale in color, in comparison with most species of *Bimastus*, and the posterior six somites were almost white from contained matter.

The specimen was not at the height of sexual activity when killed, and the clitellum is not as strongly developed as it might be, but there is a considerable development on the ventral surface of 29–33. The oviducal pores have not been located, as the oviduct, which is very imperfectly developed, can be traced only to the wall and not through it. The gonads and their ducts have the ordinary locations and relations.

This species closely resembles *H. zeteki* in size and the posterior position of the clitellum, but differs from it in several respects. The clitellum is two somites further anterior and is developed on the ventral side of a part of its somites, which is not true of the latter species. The difference in the thickening of the septa is very marked. In *H. zeteki*, septum 14/15 is uniformly one of the two thickest septa of all; while in *H. welchi*, it is very thin. The septa of the latter species which are most strongly thickened, are in *H. zeteki*, only moderately thickened. The difference in the number of longitudinal partitions in the calciferous gland, of which there are 60–64 in *H. zeteki* and in *H. welchi* but about 40, is too great to be a mere individual variation in the same species. Finally there is a marked difference in coloration.

H. welchi is a soil species and thus far is known only from the type locality.

HELODRILUS (BIMASTUS) ZETEKI Smith and Gittins.

Helodrilus (Bimastus) zeteki SMITH and GITTINS, 1915:545.

Length, 10–14 cm. Maximum diameter, 0.5–0.65 cm, at the clitellum. Color of antero-dorsal part, purplish-brown. Somites, 100–142; in complete specimens, the number usually exceeds 130. Prostomium, epilobic $\frac{1}{2}$ – $\frac{1}{4}$. Setae, closely paired; anterior to the clitellum, $aa:ab:bc:cd:dd=6:1:5:1:20$; posterior to the clitellum, bc is relatively somewhat greater and dd somewhat less. Clitellum on 27–37 and extends ventrad far enough to include the ventral setae on 30–36. Tubercula pubertatis are entirely lacking. First dorsal pore on 5/6. Spermiducal pores on 15, slightly dorsad of b . Oviducal pores on 14, slightly dorsad of b . Septa 6/7–12/13 are consid-

erably thickened and 13/14 and 14/15 more strongly thickened. Longitudinal partitions of calciferous gland, 60-64 in number. Sperm sacs in 11 and 12. Spermathecae are lacking.

H. zeteki is found in the wood and under the bark of decaying logs and sometimes under the logs. It has been collected in considerable numbers in Illinois, Indiana, and Michigan.

HELODRILUS (BIMASTUS) TENUIS (EISEN).

Allolobophora tenuis EISEN, 1874a:44.

Helodrilus (Bimastus) tenuis SMITH, 1914:364.

Allolobophora constricta ROSA, 1884:38.

Allolobophora (Bimastus) constricta MICHAELSEN, 1900:8.

Helodrilus (Bimastus) constrictus MICHAELSEN, 1900a:503.

? *Allolobophora norvegica* EISEN, 1874:48.

Length, 4-8 cm. Somites, 90-105. Color of antero-dorsal surface, rose-red; elsewhere pale. Prostomium, epilobic $\frac{3}{4}$. Setae, widely paired; $aa:ab:bc:cd:dd = 12:5:10:7:35$ is an approximation to the relation at a short distance posterior to the clitellum. Clitellum on 26-31. Tubercula pubertatis, indistinct and often lacking; when present, usually on 29 and 30, occasionally invading 31. Ventral setae of 16, usually borne on broad glandular papillae. First dorsal pore on 5/6. Spermiducal pores on 15, between *b* and *c* on prominent glandular elevations. Oviducal pores on 14, slightly dorsad of *b*. Septa but slightly thickened anywhere. Longitudinal partitions of calciferous gland, about 40 in number. Sperm sacs in 11 and 12. Spermathecae, lacking in the typical form; sometimes imperfectly developed.

Three specimens of the original collection, on which Eisen's description of *H. tenuis* was based, were given by him to the United States National Museum; and one of these has been partially sectioned as a basis for the study of the internal anatomy and hence of the relationships of the species.

This specimen is strongly contracted and obviously has lost the posterior end. The length is but 2.2 cm. and the number of somites but 80. On somite 35, $aa:ab:bc:cd:dd = 7:3:6:4:15$. The clitellum is on 26-31, but not strongly developed, and the specimen was apparently not at the height of sexual activity. Tubercula pubertatis are on 29 and 30 and include setae *b*. Septa 7/8-9/10, 13/14, and 14/15 are very slightly thickened. Longitudinal partitions of the calciferous gland are about 40 in number, but can not be exactly enumerated in the longitudinal sections of one side. The "hearts" are in 7-11, the last pair being about as large as those of 10. There are paired sperm sacs in 11 and 12, and there are no traces of spermathecae.

It is practically certain that this is the species which has been identified as *H. constrictus* in this country, and highly probable that it is the same as the *H. constrictus* of other regions.

The great majority of *H. tenuis* collections examined by the writer have contained only normal specimens; but four collections made in different localities have each contained in close association specimens without spermathecae and others with imperfectly developed spermathecae. The largest of these collections includes 30 or more specimens taken near Burt Lake, Cheboygan County, Michigan, in 1911, from an old manure heap composed of horse manure and sawdust that had been used for bedding. Sections were made from 10 of these specimens. One shows no trace of spermathecae, two show parts of ducts but no sacs, and the others show from one to three sacs with ducts, but never four. They are all at 9/10 and 10/11 in line with setae *c*. A small collection is from a rotten log near Douglas Lake in the same county as above. Sections were made from three specimens. One has a definite duct without sac at 10/11 and no other traces, and the other two specimens show no traces of spermathecae. Two specimens were sectioned from a collection made in a rotten log at Macatawa, Allegan County, Michigan. One specimen shows no traces of spermathecae, and the other one has a sac and duct at 9/10 and a trace of a duct at 10/11 on one side and no traces on the other. A collection was made under a rotting straw stack near Fremont, Steuben County, Indiana, a few miles from the Michigan State line. Two of four specimens sectioned show no traces of spermathecae. Another one shows a sac and duct at 9/10 on one side. The fourth one has a small sac and duct at 10/11 on one side and no traces of others.

The aberrant specimens are indistinguishable in other ways from the normal ones and presumably have come from the same parents or immediate ancestors. They are very similar to *H. norvegicus* of Europe, which Michaelsen has suggested may have arisen through retrogression from *H. constrictus*. I have hesitated to identify the American specimens with *H. norvegicus* since they differ slightly, and I do not know that there is evidence of such close association between the two European forms. *H. norvegicus* is described by both Eisen (1874 : 48) and Michaelsen (1902 : 6) as having the clitellum on 26–32, and the tubercula pubertatis as commonly including 31. In the *H. tenuis* specimens with spermathecae which I have examined, the clitellum very uniformly extends only to the anterior edge of 32, and the tubercula pubertatis includes only 29 and 30. The only exception is a Burt Lake specimen which has not been sectioned but which has the clitellum on 26–32 and the tubercula pubertatis of one side on 30 and 31. None of the *H. tenuis* material from the other parts of North America outside of Michigan and its immediate vicinity are known to develop any traces of spermathecae.

All of the species of the subgenus *Bimastus* found in North America with the exception of *H. tenuis* are presumably indigenous and form

a quite homogeneous group. In addition to the characters mentioned in the definition, they all have closely paired setae, and no traces of spermathecae have been found in them. Since *H. zeteki* has the clitellum extending posteriorly as far as 37, the anterior position can no longer be considered as characteristic of the subgenus. In view of the tendency of *H. tenuis* to develop spermathecae, it might simplify matters to place it in a subgenus, as *Dendrobaena*, which normally has spermathecae and leave *H. oculatus* in the subgenus *Eophila*, and thus have a much more homogeneous group in *Bimastus*. Michaelsen is certainly justified in considering the border line between *Bimastus*, *Dendrobaena*, and *Eophila* as one of the most puzzling problems in the system of Lumbricidae.

H. tenuis is most commonly found in and under fallen timber and in leaf mold and has been reported as *H. constrictus*, from various places in Europe, Asia, and South America. In North America, it has been listed from Mexico, New York, Illinois, California, Canada, Vancouver, and Alaska.

New localities: Maine, Ohio, Indiana, Michigan, Colorado, Washington, and Bering Island.

Genus OCTOLASIUM Örley, emended by Rosa.

Prostomium, usually epilobic, occasionally tanylobic. Spermathecae, four pairs in 9-12. Spermathecae and spermiducal funnels, enclosed in paired sperm vesicles or in narrow chambers. Setae, usually widely paired or separate. Örley (1885 : 13). Rosa (1893 : 424).

OCTOLASIUM LACTEUM (Örley).

Lumbricus terrestris var. *lacteus* ÖRLEY, 1881: 584.

Octolasion lacteum ÖRLEY, 1885: 21.

Octolasion lacteum MICHAELSEN, 1900a: 506.

Allolobophora profuga ROSA, 1884: 47.

Length, very variable, 5-16 cm. Somites, 100-165. Color of few anterior somites, pale pinkish; posterior end is pale; remainder of body except clitellum is blue-gray when the intestine contains the usual amount of earthy matter. Prostomium, usually epilobic $\frac{1}{2}$ - $\frac{3}{4}$; occasionally tanylobic. Setae anterior to the clitellum, definitely paired, and *ab* less than *bc*; posterior to the clitellum, the setae are scarcely paired, and *ab* is equal to or greater than *bc*; *bc* is greater than *cd*, in general. Clitellum on 30-35. Tubercula pubertatis on 31-34. First dorsal pore on 8/9, 9/10, or 10/11. Spermiducal pores on 15; nearer to *c* than to *b*. Oviducal pores on 14, slightly dorsad of *b*. Spermathecal pores on 9/10 and 10/11, in line with *c* or *d*. Septa 6/7-8/9, slightly thickened; and 9/10-13/14, still less thickened. The calciferous gland communicates at its anterior end with the esophagus in 10 and has about 45 longitudinal partitions. Spermathecae and spermiducal funnels in 10 and 11, included

in sperm vesicles. Sperm sacs in 9–12; those of 9 and 10 being quite different in form and appearance from those of 11 and 12 which resemble those commonly found in Lumbricidae. The sperm sacs of 9 and 10 are digitiform and have a definite lumen extending through the greater part of the length.

O. lacteum is commonly found under logs, leaf mold, and débris of various kinds, and in compost heaps and to some extent in soil. It is widely distributed in Europe and in various parts of the world where Europeans have settled and has been reported from Illinois, California, and Mexico.

New localities: Ohio, Indiana, and Colorado.

Genus LUMBRICUS Linnaeus, emended by Eisen.

Prostomium, tanylobic. Sperm sacs, three pairs; in 9, 11, and 12. Spermaries and spermiducal funnels, enclosed in an unpaired median chamber. Setae, closely paired, posteriad of the clitellum. Linnaeus (1758: 647). Eisen (1874: 45).

LUMBRICUS RUBELLUS Hoffmeister.

Lumbricus rubellus HOFFMEISTER, 1843: 187.

Length, 7–15 cm. Somites, 95–150. Color, reddish-brown or violet; more pronounced on antero-dorsal surface. Prostomium, tanylobic. Setae closely paired; $aa:ab:bc:cd:dd=5:1:5:\frac{4}{5}:19$. Clitellum on 27–32, exceptionally beginning on 26. Tubercula pubertatis on 28–31. First dorsal pore on 7/8. Spermiducal pores on 15 and inconspicuous; between *b* and *c*. Oviducal pores on 14, slightly dorsad of *b*. Spermathecal pores on 9/10 and 10/11, in line with *cd*. Septa 6/7–8/9, somewhat thickened; others but very little, except in parts adjacent to the attachments of the sperm sacs. Longitudinal partitions of the calciferous gland, about 60 in number. Sperm sacs in 9, 11, and 12. Spermathecae in 9 and 10, in the specimens examined.

L. rubellus in the collections of the writer have mostly come from under débris along shores. The species is widely distributed in Europe and Siberia; and in North America has been reported from Newfoundland, California, Oregon, and Washington.

New locality: Michigan (Cheboygan and Gogebic Counties).

LUMBRICUS CASTANEUS (Savigny).

Enterion castaneum SAVIGNY, 1826: 180, 181.

Lumbricus castaneus DUGÈS, 1837: 17, 22.

Lumbricus purpureus EISEN, 1871: 956.

Length, 3–5 cm. Somites, about 90. Color dorsally, chestnut brown to brown violet. Prostomium, tanylobic. Setae, closely paired; $aa:ab:bc:cd:dd=4:1:4:\frac{4}{5}:16$. Clitellum on 28–33. Tuber-

cula pubertatis on 29-32. First dorsal pore on 6/7. Spermiducal pores on 15; inconspicuous. Oviducal pores on 14; slightly dorsad of *b*. Spermathecal pores on 9/10 and 10/11; in line with *cd*. Septa very thin, in the only specimen examined. Sperm sacs in 9, 11, and 12. Spermathecae in 9 and 10, in one specimen.

H. castaneus has been reported from northern and middle Europe and from Canada and New York.

LUMBRICUS TERRESTRIS Linnaeus, Müller.

Lumbricus terrestris LINNAEUS, (part) 1758:647.

Lumbricus terrestris O. F. MÜLLER, (part) 1774:24.

Enterion herculeum SAVIGNY, 1826:180.

Lumbricus herculeus DUGÈS, 1837:17, 21.

Lumbricus agricola HOFFMEISTER, 1842:24.

?*Lumbricus americanus* PERRIER, 1872:44.

Length, 10-30 cm. Somites, 110-180. Color, antero-dorsal surface brownish-violet. Prostomium, tanylobic. Setae, closely paired; posterior to the clitellum, $aa:ab:bc:cd:dd = 4:1:3\frac{1}{2}:\frac{3}{4}:16$. Clitellum on 32-37, sometimes beginning on 31. Tubercula pubertatis on 33-36. First dorsal pore on 7/8. Spermiducal pores on 15, between *b* and *c*. Oviducal pores on 14, slightly dorsad of *b*. Spermathecal pores on 9/10 and 10/11, in line with *cd*. Septa 6/7-9/10, strongly and 10/11-14/15, moderately thickened. Longitudinal partitions of the calciferous gland, 70-75 in number. Sperm sacs in 9, 11, and 12. Spermathecae in 9 and 10.

L. terrestris is widely distributed in Europe and has been reported in North America from Newfoundland, Massachusetts, Illinois, New York, and Mexico.

New localities: Maine, Connecticut, Maryland, District of Columbia, Ohio, Michigan, Minnesota, Colorado, and California.

LUMBRICUS FESTIVUS (Savigny).

Length, 5.5-10 cm. Somites, 100-120. Color, light red brown. Setae, closely paired. Clitellum on 34-39. Tubercula pubertatis on 35-38. First dorsal pore on 5/6. Spermiducal pores on 15, with elevated glandular area.

L. festivus has been reported from Scotland, England, and France. It is also reported by Stafford (1902:483) as occurring in Canada.

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THE BIRDS OF BAWEAN ISLAND, JAVA SEA.

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Bawean Island lies in the Java Sea, about 175 miles south of Borneo, and about 75 miles north of eastern Java. It is nearly square, some 11 miles long by 10 miles wide, and has an area of approximately 100 square miles. The surface is mountainous, and the highest point reaches an altitude of about 2,200 feet above sea level. The island is of volcanic origin and has still many volcanic cones and some hot springs. Its rocks are chiefly lava, basalt, and limestone; and extensive coral reefs fringe its coastal base. A lake of some 15 acres occupies the crater of Mount Telaga, an extinct volcano.

The island supports a human population of about 50,000, mostly near the coast, and these inhabitants speak a peculiar language. Little of the virgin forest remains: the largest tract is on the northern slope of the mountains in the center of the island; another area lies on the western coast; and the rest comprises only a few small patches on the eastern and southern slopes of the mountains. Low brush and tall bamboos cover most of the remaining portions of the island. There are numerous cattle on Bawean, and their trails run everywhere through the scrub. Wild mammals, except for two or three species, chiefly pigs and flying foxes, are not numerous.

Dr. W. L. Abbott visited Bawean Island from November 19 to 28, 1907, and made a collection of 35 specimens of birds, which he presented to the United States National Museum. This collection, though small, is of much interest, since 7 of the 15 species represented prove to belong to undescribed forms, most of them, so far as known, confined to this island.

Previous to Doctor Abbott's visit, knowledge of the birds of Bawean Island came chiefly from a short article by Dr. A. G. Vorderman,¹ in which he records 18 species, mostly from specimens collected. Doctor Abbott found birds very scarce, but his collection adds 8 species to the list, making a total of 26 now known to inhabit this

¹ *Natuurk. Tijds. Nederlandsch-Indië*, vol. 51, 1892, pp. 417-422.

island. These are as follows, those marked with an asterisk being unrepresented in Doctor Abbott's collection:

1. *Fregata minor minor* (Gmelin).
2. *Butorides javanicus javanicus* (Horsfield).*
3. *Ardea sumatrana* Raffles.*
4. *Spilornis bassus baweanus* Oberholser.¹
5. *Gallus varius* (Shaw).
6. *Actitis hypoleuca* (Linnaeus).*
7. *Geopelia striata* (Linnaeus).*
8. *Chalcophaps indica* (Linnaeus).*
9. *Spilopelia tigrina* (Temminck).
10. *Cuculus canorus telephonus* Heine.
11. *Eudynamis honorata* (Linnaeus).*
12. *Sauropatis chloris cyanescens* Oberholser.
13. *Ceyx rufidorsus innominatus* Salvadori.*
14. *Strix baweana* Oberholser.²
15. *Collocalia linchi linchi* Horsfield and Moore.*
16. *Pycnonotus plumosus plumosus* Blyth.
17. *Microtarsus chalccephalus baweanus* (Finsch).
18. *Microtarsus atriceps abbotti* Oberholser.¹
19. *Malococincla abbotti baweana* Oberholser.¹
20. *Orthotomus cineraceus* Blyth.*
21. *Gracula javensis baweana* Oberholser.¹
22. *Anthreptes malacensis baweanus* Oberholser.¹
23. *Cinnyris ornata ornata* Lesson.
24. *Dicaeum flammeum* (Sparrman).
25. *Ploceus manyar* (Horsfield).*
26. *Munia punctulata nisoria* (Temminck).*

As may be seen by examination of the above list of Bawean birds, the avifauna of this island is, on the whole, most closely allied to that of Java, but it has also a marked Bornean infusion.

The only published papers of any consequence treating of the birds of Bawean Island are the two cited below, and the second of these mentions but a single species:

VORDERMAN, A. G. Bijdrage tot de Kennis der Avifauna van het Eiland Bawean-Natuurk. Tijds. Nederlandsch-Indië, vol. 51 (ser. 8, vol. 12), 1892, pp. 417-422.

FINSCH, O. Zur Catalogisirung der Ornithologischen Abtheilung.—*Brachypodius baweanus*: Notes Leyden Mus., vol. 22, March, 1901, pp. 209-211.

The writer is indebted to Doctor Abbott for the above given descriptive facts concerning Bawean Island; and, as usual, to Dr. C. W. Richmond, assistant curator of the Department of Birds in the United States National Museum, for various courtesies.

Measurements in this paper are all given in millimeters; and have been taken as in the author's paper on *Butorides virescens*.³ The names of colors are from Mr. Ridgway's recently published Color Standards and Color Nomenclature.

Notes on Doctor Abbott's specimens follow.

¹ New subspecies, described beyond.

² New species, see p. 190.

³ Proc. U. S. Nat. Mus., vol. 42, 1912, p. 533.

Family FREGATIDAE.

FREGATA MINOR MINOR (Gmelin).

[*Pelecanus*] *minor* GMELIN, Syst. Nat., vol. 1, pt. 2, 1789, p. 572 (no locality; type locality designated as "the eastern half of the Indian Ocean," by Rothschild, Novit. Zool., vol. 22, February, 1915, p. 145).

One specimen: Adult male, No. 181398, U.S.N.M., November 21, 1907. "Iris brown; bill pale leaden; gular pouch brick red; feet dark brown." It is in good adult plumage though molting some of the contour feathers, particularly on the cervix; and the wings and tail are intact. It measures: Total length (in flesh), 870 mm.; wing, 545; tail, 390; exposed culmen, 103; tarsus, 20.3; middle toe, 45.

This example agrees, in so far as I can see, with the birds from the eastern Indian Ocean. The name for this race is, as Doctor Rothschild has shown,¹ *Fregata minor minor*, since the original *Pelecanus minor*² applies pretty certainly to the East Indian bird; at least not to that of the West Indies as Mr. Mathews has contended.³

Family BUTEONIDAE.

SPILORNIS BASSUS BAWEANUS, new subspecies.⁴

Subspecific characters.—Similar to *Spilornis bassus bassus* from Sumatra, but smaller, and darker both above and below.

Description.—Type, adult female, No. 181446, U.S.N.M.; Bawean Island, Java Sea, November 25, 1907; Dr. W. L. Abbott. Pileum black, the feathers all with pure white bases which show through the black, particularly on the occiput, in the form of irregular spots; rest of upper surface clove brown, the feathers marginally rather lighter, the back sparingly sprinkled with small dots of dull white, the scapulars and feathers of rump and upper tail-coverts tipped with white; tail above with a broad basal band, extending about 80 mm. from the root of the feathers, clove brown, this succeeded by another broad band, about 35 to 40 mm. wide, of brownish black, this followed in turn by a broad band, 35 mm. wide on outer pair of rectrices, 50 mm. wide on middle pair, of tulle buff, partly paling to white on the inner webs of outer feathers, everywhere heavily mottled and clouded with grayish avellaneous, least so on the inner webs of outermost rectrices, this again succeeded by still another wide band of slightly brownish black, and finally tipped narrowly (3 to 8 mm.) with avellaneous; under surface of tail with a broad basal band of white, mottled with mouse gray, a narrower succeeding

¹ Novit. Zool., vol. 22, February 12, 1915, pp. 145-146.

² Gmelin, Syst. Nat., vol. 1, pt. 2, 1789, p. 572.

³ Austral Avian Record, vol. 2, December 19, 1914, p. 118; Birds Australia, vol. 4, pt. 3, June 23, 1915, pp. 240-281.

⁴ An earlier name for *Falco bacha* Daudin (*Spilornis bacha* Authors) is *Falco bassus* J. R. Forster (Naturgesch. African. Vögel, 1798, p. 55); and this species should therefore stand as *Spilornis bassus* (Forster). See Richmond, Proc. U. S. Nat. Mus., vol. 35, 1902, p. 592.

band of brownish black, another band of dull white clouded with mouse gray, still another of brownish black, and a relatively narrow paler tip of drab, between pale drab and avellaneous; primaries and secondaries brownish black, with two or three broad lighter bars, these dark brown, between olive brown and clove brown, on the outer webs, but changing partly or even largely to white mottled with the same brown on the inner side of the inner webs; tertials between olive brown and clove brown, more or less barred obscurely with a darker shade; all the wing-quills tipped with dull white; lesser wing-coverts brownish black, each feather with two white roundish terminal spots; median and greater coverts brown, between olive brown and clove brown, with obsolescent, in many cases broken, bars of darker, and two or more irregular terminal white markings on each feather, these spots varying much in size; lores and orbital ring naked, with but a few black hairs; supra-auricular region black like the crown; extreme anterior portion of chin and anterior end of malar stripe brownish black, the latter passing posteriorly into the blackish clove brown of cheeks and auricular region; rest of lower surface clove brown, lighter and shading toward olive brown on breast, sides of neck, and longest under tail-coverts, the chin, throat, and jugulum practically immaculate, with but an occasional small roundish spot of white; the breast and abdomen thickly marked with large roundish spots of white, these usually 10 or 12 on each feather, and mostly in pairs; the thighs and crissum with large more or less quadrangular pairs of white spots that almost coalesce into bars and occupy a relatively much larger portion of each feather than do the markings on the abdomen, thus producing a lighter general effect; axillars dark olive brown, with several pairs of large white spots; under wing-coverts varying from olive brown to brownish black, very heavily spotted and barred with white; "bill leaden, tip black."

This newly discovered race is apparently most closely allied to the Sumatran bird, which is true *Spilornis bassus*. The difference in size is chiefly in the bill, and otherwise is not very great, but the color characters separate it without difficulty. The Bawean bird is so much larger and darker than the Bornean *Spilornis pallidus* that it scarcely needs comparison.

The four birds obtained by Doctor Abbott are all adults in good plumage. Two of them, including the type, are in the regular brown phase of plumage; and the colors of the soft parts of the one other than the type, were, as indicated on the label: "Iris yellow; naked skin about eye yellow; feet dirty yellow." The two other birds are in the curious light phase, known in only a few forms of the genus, but apparently a true color phase, as this condition is certainly not due to age, sex, or season. It is characterized by a white head and lower parts and is very strikingly different from the normal phase. It is described below:

Adult male, No. 181444, U.S.N.M.; Bawean Island, Java Sea, November 27, 1907; Dr. W. L. Abbott. Pileum creamy white, the feathers of the central portion of crown and occiput with blackish brown subterminal bars, these broken or incomplete on the crown; cervix and rest of upper surface white with broad subterminal bars of fuscous black, fuscous, and light clove brown, these bars shading proximally into pale brown or buffy, very little of the light color showing on the upper surface posterior to the hind neck; tail basally pale clove brown, distally brownish black or blackish brown, crossed by two broad bars of mottled wood brown, shading in same places to avellaneous; wing-quills brown, varying from light to dark clove brown and fuscous, the greater portion of inner webs together with tips of all, white, barred throughout with blackish brown or brownish black; superior wing-coverts, their bases (except for brown bars) and their broad tips white, the lesser coverts more blackish; sides of head white, the auriculars much mixed with fuscous; sides of neck white, barred broadly with fuscous; lower surface white, posteriorly more or less washed with buffy, and with a slight malar streak of black, a few hastate markings of fuscous on breast, jugulum, and abdomen, rather broad irregular bars of warm fuscous on sides and flanks, narrow bars of same on thighs, and a few narrow more or less hastate pale brown bars on crissum; lining of wing white; "bill leaden, tip black; face yellow; iris pale greenish; feet brownish yellow."

The specimens collected by Doctor Abbott are all included in the following table of measurements:

Measurements of specimens of Spilornis bassus baweanus.

[Collected by Dr. W. L. Abbott.]

U.S.N.M. number.	Sex.	Locality.	Date.	Total length. ¹	Wing.	Tail.	Exposed culmen.	Culmen from cere.	Tarsus.	Middle toe.
181444	Male....	Bawean Island.....	Nov. 27, 1907	mm. 524	mm. 328	mm. 231	mm. 30.5	mm. 24.8	mm. 72	mm. 35
181447	Female....	.....do.....	Nov. 19, 1907	510	330	208	32.5	25.5	76.5	37
181446	.....do.....	.....do.....	Nov. 25, 1907	512	328	213	32	27	72	33
181445	.....do.....	.....do.....	Nov. 27, 1907	523	328	219	33	27.5	76	33.5

Family PHASIANIDAE.

GALLUS VARIUS (Shaw).

Phasianus varius SHAW, in Shaw and Nodder, Nat. Misc., vol. 10, October, 1798, text to pl. 353 ("probably India"; locality wrong: I substitute Java as the type locality).

Two specimens:

Adult male, No. 181412, U.S.N.M.; November 28, 1907. Total length (in flesh) 545 mm. "Iris yellow; a narrow yellow line on

¹ Measured in the flesh by the collector.

² Type.

skin at front of neck, at upper edge of feathers; feet pale fleshy; front of tarsi and top of toes pale fleshy brown."

Nearly adult male, No. 181413, U.S.N.M.; November 20, 1907. Total length (in flesh) 593 mm. "Iris yellow brown; feet pale brownish fleshy."

Both these birds seem to be absolutely identical with examples from Java. They represent, therefore, a considerable northward extension of the range of the species. The immature specimen (No. 181413, U.S.N.M., Nov. 20) lacks but little of being adult, though the feathers of the lower parts are dull, some of them edged with rusty or pale brown; many of the wing-quills and superior coverts are barred with buff or tawny; the throat, sides, and top of the head are pretty well feathered; and the frontal comb is rudimentary. Some of the contour feathers are being replaced by molt.

Family CLARAVIIDAE.

SPILOPELIA TIGRINA (Temminck).

Columba tigrina TEMMINCK, Hist. Nat. générale des Pigeons, vol. 1, 1808-1811, pl. 43 [p. 158] (Batavia, Java).

Two specimens:

Adult male, No. 181417, U.S.N.M.; November 19, 1907. Length (in flesh), 300 mm.

Adult female, No. 181418, U.S.N.M.; November 19, 1907. Length (in flesh), 295 mm.

Both are in good plumage, though showing slight indications of molt among some of the contour feathers, particularly about the head and neck. They seem, furthermore, to be identical in both size and color with birds from the Malay Peninsula.

The genus *Spilopelia*,¹ here used for this species, is well differentiated from *Stigmatopelia*² by its longer tail, stouter bill and feet, and less tumid cere; and both *Spilopelia* and *Stigmatopelia* may readily be distinguished from *Streptopelia* (olim *Turtur*) by the peculiar bifurcate feathers of the neck and by other characters.

Family CUCULIDAE.

CUCULUS CANORUS TELEPHONUS Heine.

Cuculus telephonus HEINE, Journ. für Ornith., for September, 1863 (probably December, 1863), p. 352 (Japan).

One male, in immature plumage, No. 181464, U.S.N.M.; Bawean Island, November 21, 1907; "eyelids yellow; bill dark horn brown, greenish beneath at base; inside of mouth orange; feet yellow." Length, 331 mm.³

¹ *Spilopelia* Sundevall, Meth. Nat. Avium Disp. Tent., 1873, p. 100 (type, *Columba chinensis* Scopoli).

² *Stigmatopelia* Sundevall, Meth. Nat. Avium Disp. Tent., 1873, p. 100 (type, *Columba senegalensis* Linnaeus).

³ Measured in the flesh by the collector.

Family ALCEDINIDAE.

SAUROPATIS CHLORIS CYANESCENS, new subspecies.

Subspecific characters.—Similar to *Sauropatis chloris chloris*, but averaging smaller; male with upper surface rather more bluish, with less contrast between back and wings; ear-coverts more greenish; blackish nuchal band narrower, less distinct, and more overlaid by green; female with upper parts averaging darker; wings somewhat more bluish; ear-coverts more greenish; blackish nuchal band usually more washed with greenish.

Type.—Adult male, No. 170835, U.S.N.M.; Pulo Taya off the southeastern coast of Sumatra, July 28, 1899; Dr. W. L. Abbott.

Measurements.—Thirteen males average as follows: Wing, 109.3 mm.; tail, 67.7; exposed culmen, 45.3; tarsus, 16.4.

Geographical distribution.—Sumatra, Borneo, and neighboring islands.

The birds from Borneo, Sumatra, and many of their adjacent islands differ from other forms of the species, and are apparently worthy of subspecific separation.

Three specimens from Bawean Island are the same, though averaging slightly larger. Two of these (Nos. 181494 and 181495, U.S.N.M., taken, Nov. 20, 1907) are in molt of the contour feathers, remiges, and rectrices. Measurements of all are as follows:

Measurements of specimens of Sauropatis chloris cyanescens.

[Collected by Dr. W. L. Abbott.]

U.S.N.M. number.	Sex.	Locality.	Date.	Total length. ¹	Wing.	Tail.	Exposed culmen.	Tarsus.
181495	Male....	Bawean Island.....	Nov. 20, 1907	mm. 254	mm. 111.3	mm. 71.5	mm. 42	mm. 18.5
181493	Female....	.....do.....	Nov. 19, 1907	262	110.8	73	46.5	17
181494	.....do.....	.....do.....	Nov. 20, 1907	265	114.5	69	48.3	17.3

This species is generically distinct from true *Halcyon* (type, *Halcyon senegalensis*) and should take the generic name *Sauropatis* Cabanis and Heine,² of which the type is *Halcyon sanctus* Vigors and Horsfield.

¹ Measured in the flesh by the collector.² Mus. Hein., pt. 2, January, 1860, p. 158.

Family BUBONIDAE.¹*STRIX BAWEANA*, new species.

Specific characters.—Resembling *Strix orientalis seloputo* Horsfield, from Java, but much smaller and paler throughout; white spots on upper surface much reduced, more roundish, and less inclined to form bars; dark brown bars on lower surface much narrower.

Description.—Type, adult female, No. 181450, U.S.N.M.; Bawean Island, Java Sea, November 27, 1907; Dr. W. L. Abbott. Upper surface (in somewhat worn plumage) brown, between cinnamon brown and tawny, in places becoming more ochraceous, everywhere with roundish dots of dull white which on the nape and scapulars incline to irregular bars, the longer scapulars broadly barred with white and narrowly with clove brown and the brown of the upper surface; tail sepia, shading basally and on the inner webs of the feathers to cinnamon and cinnamon buff, barred with dull creamy white, broadly on inner webs, narrowly and irregularly on outer webs; primaries between clove brown and sepia, shading gradually on outer webs to cinnamon buff at the base, more or less sparingly spotted or barred on the outer vanes with creamy white, cream buff, and buff; broadly on inner vanes with various shades of lighter brown, tawny, ochraceous, and buff, the inner feathers tipped with whitish; secondaries and tertiaries sepia, broadly, but in places brokenly, barred with dull brown (between buffy brown and olive brown), dull white, and various shades of ochraceous, buff, and tawny, and tipped with dull white; wing-coverts brown like the back, the lesser series sparingly spotted with whitish, the median and greater series on the outer webs broadly barred with white and narrowly with clove brown, on the inner webs broadly with buffy white, buff, and ochraceous; facial disks dull cream buff, unmarked; entire lower surface creamy white, much tinged in places by the buffy clay color of the bases of the feathers, which show through, particularly on the throat, where they form a conspicuous throat patch; all the lower parts, except the chin, conspicuously, and regularly though rather narrowly barred with clove brown, most broadly on the throat; thighs and tarsi dull white, much tinged in places with cinnamon buff, and narrowly barred throughout with clove brown; lining of wing mixed creamy white, buff, and ochraceous, spotted and more or less barred with dark rufescent

¹ The family name Bubonidae should be retained for the horned owls and their allies, notwithstanding that the generic name *Strix* has been transferred to one of the genera of this group; for rather than to take the oldest generic name in a family as the basis for the family name, it is much better for various reasons to adhere for the family designation to the type genus (i. e., the genus from which the family name was first formed) whatever may subsequently become its generic name. This is a course parallel to that pursued in the case of type species of genera; is much more logical; and will obviate much, in fact nearly all, of the confusion arising from the transfer of family names from one group to another. In the present instance *Bubo* is the type genus of the family Bubonidae.

brown. Total length (in flesh),¹ 412 mm.; wing, 297; tail, 158; exposed culmen, 31; culmen without cere, 22.3; tarsus, 55; middle toe, 30.

Although this new bird, of which Doctor Abbott obtained unfortunately but a single specimen, is undoubtedly most closely allied to *Strix orientalis* Shaw (= *Strix sinensis* Latham), it is so different in coloration that it seems certainly to be specifically distinct. The dark barring of the lower surface is strikingly like that in *Strix ocellata*, but the upper parts are of course very different.

The name *Strix sinensis* Latham,² used by some authors for *Strix orientalis* Shaw, is preoccupied by a previous *Strix sinensis* of the same author;³ but *Strix orientalis* Shaw,⁴ a new name for *Strix sinensis* Latham, is not invalidated by *Strix orientalis* Linnaeus⁵ from Hasselquist, since, according to the International Code of Nomenclature, the scientific names in Hasselquist's *Reise nach Palästina* (1762) have no standing, because they occur in a mere translation of a pre-Linnaean work. The proper designation for the whole species is therefore *Strix orientalis* Shaw.

Representatives of *Strix orientalis* from Java differ considerably from those inhabiting the Malay Peninsula (*Strix orientalis orientalis*), in their narrower dark barring below, particularly on the breast, and their much larger white markings on the upper parts. The name for the Javan race is *Strix orientalis seloputo* Horsfield.⁶

FAMILY PYCNONOTIDAE.

PYCNONOTUS PLUMOSUS PLUMOSUS Blyth.

Pycnonotus plumosus BLYTH, Journ. Asiatic Soc. Bengal, vol. 14, pt. 2, December, 1845, p. 567. (Singapore, Singapore Island).

Three specimens are in the collection, as follows:

Adult male, No. 181542, U.S.N.M.; November 19, 1907. Length (in flesh), 200 mm.

Adult female, No. 181540, U.S.N.M.; November 24, 1907.

Juvenal female, No. 181541, U.S.N.M.; November 19, 1907.

These are identical, so far as I can discover, with typical birds from the Malay Peninsula. One of the adults (No. 181542, U.S.N.M.) and the juvenile (No. 181541, U.S.N.M.) are in process of molt, though wings and tail are perfect. The juvenile plumage differs from that of the adult in being throughout, particularly on the rump, more brownish, the upper surface paler, and the lower parts more tinged with yellowish.

¹ Measured by the collector.

² Suppl. Indics Ornith., 1801, p. xvi (China).

³ Latham, Index Ornith., vol. 1, 1790, p. 53.

⁴ Gen. Zool., vol. 7, pt. 1, 1809, p. 267 (China).

⁵ In Hasselquist, *Reise Paläst.*, 1762, p. 290 (Egypt and Syria).

⁶ *Strix Seloputo* Horsfield, Trans. Linn. Soc. Lond., vol. 13, pt. 1, May, 1821, p. 140 (Java).

MICROTARSUS CHALCOCEPHALUS BAWEANUS (Finsch).

Brachypodius baweanus FINSCH, Notes Leyden Mus., vol. 22, March, 1901, p. 209 (Bawean Island).

Eight specimens—three females and five males—of this interesting bird were collected by Doctor Abbott.

In pattern of coloration this species is practically identical with *Microtarsus atriceps*, but the olive and yellow colors of the latter are everywhere replaced by gray and white. In the females, as compared with the males, the upper surface is of a darker, duller gray; the gray of the inferior parts is somewhat darker, and the abdomen and crissum more washed with gray. One of the males (No. 181558, U.S.N.M.) has a streak of olive yellow on the outer web of one of the secondaries, one of the tertials, and one of the rectrices, which may be lingering indications of immaturity. Several of the secondaries of one of the females (No. 181551, U.S.N.M.) show the same thing. The labels state that in both males and females the iris is blue, the bill and feet black. Nearly all of our specimens exhibit evidences of molt among the contour feathers, particularly about the head and neck; but only one (No. 181557, U.S.N.M.) is changing either remiges or rectrices, and this one is molting both.

Our series proves that *Microtarsus baweanus* is a subspecies of *Microtarsus chalconcephalus* of Java; for while the characters given by Finsch¹ to separate it from the latter will serve to diagnose it, individual variation practically bridges the difference between the two. Both the upper and lower parts, while normally much paler in *Microtarsus baweanus*, are in some of our specimens almost as dark as in *Microtarsus chalconcephalus*; the base of the tail, while almost white in some examples, is in others nearly as dark as in *Microtarsus chalconcephalus*; the subterminal black band on the rectrices, though sometimes broken or even reduced to spots, is in other specimens as wide as in the Javan bird; and the terminal white bar on the tail shows also much variation in width. Measurements are as follows:

¹ Notes Leyden Museum, vol. 22, 1901, p. 209.

Measurements of specimens of *Microtarsus chalconcephalus baweanus*.

[Collected by Dr. W. L. Abbott.]

U.S.N.M. number.	Sex.	Locality.	Date.	Total length. ¹	Wing.	Tail.	Exposed culmen.	Tarsus.	Middle toe.
				mm.	mm.	mm.	mm.	mm.	mm.
181552	Male....	Bawean Island....	Nov. 22, 1907	175	73.5	67	12.3	14.8	11.5
181554	do.....	do.....	do.....	181	78	67.5	14	15.5	11.5
181556	do.....	do.....	do.....	180	80	67.5	12	15	11
181557	do.....	do.....	do.....	189			12	14.5	11.3
181558	do.....	do.....	do.....	177	76	67	13	14.5	11.8
Average of 5 males.....				175.5	78.1	67.3	12.7	14.9	11.4
181551	Female	Bawean Island....	Nov. 19, 1907	185	80	73	12.5	15.5	11
181553	do.....	do.....	Nov. 22, 1907	173	77.5	69	13	15.3	11.8
181555	do.....	do.....	do.....	172	74.5	66	12	14.8	11.5
Average of 3 females.....				176.7	77.3	69.3	12.5	15.2	11.4

MICROTARSUS ATRICEPS ABBOTTI,¹ new subspecies.

Subspecific characters.—Resembling *Microtarsus atriceps atriceps*⁴ from the type region (Sumatra), but upper parts duller olive green, much less golden; lower surface paler, more greenish in tone.

Description.—Type, adult male, No. 181549, U.S.N.M.; Bawean Island, Java Sea, November 22, 1907; Dr. W. L. Abbott. Top and sides of head, also chin and throat, brownish black, with a metallic green or purplish sheen; cervix, back, scapulars, and rump, yellowish olive green, becoming still more yellowish on the last, where also the feathers have partly concealed broad brownish black subterminal bars; upper tail-coverts pyrite yellow; tail light yellowish olive, the outer pair of rectrices dull grayish subterminally, all the rest broadly barred subterminally with brownish black, and all of them tipped broadly, the middle pair less so, with strontian yellow; wings fuscous, the lesser coverts, median coverts, outer webs of greater coverts, and outer webs of tertials, yellowish olive green, the greater coverts, tertials, and secondaries margined externally with pyrite yellow, and all the wing-quills more or less edged basally with brownish or yellowish white; breast yellowish warbler green; passing gradually into the lemon chrome of abdomen and crissum; sides and flanks like the last, but slightly washed with greenish; axillars strontian yellow; under wing-coverts pale primrose yellow; "iris blue; bill and feet black."

¹ Measured in the flesh by the collector.² Molting.³ Named for Dr. W. L. Abbott.⁴ The specific term of *Microtarsus melanocephalos*, which is the *Lanius melanocephalos* of Gmelin, Syst. Nat., vol. 1, pt. 1, 1788, p. 309, is preoccupied by *Lanius melanocephalus* Gmelin, Syst. Nat., vol. 1, pt. 1, 1788, p. 301, a synonym of *Pomatorhynchus senegalus* Linnaeus. The next available name for the species is *Turdus atriceps* Temminck, Planches Coloriées d'Oiseaux, vol 2, livr. 25, August, 1822, pl. 147 and text (Sumatra and Java).

This very distinct subspecies is the most greenish of all the forms of *Microtarsus atriceps*. It differs from *Microtarsus atriceps chrysophorus*,¹ of South Pagi Island, western Sumatra, as it does from *Microtarsus atriceps atriceps*, though even more markedly; and from *Microtarsus atriceps hyperemnus*¹ of Simalur Island, western Sumatra, in much the same way as well as additionally in much slenderer bill.

Doctor Abbott obtained two adult specimens, male and female, in perfect plumage. The female is practically identical with the male. The measurements of both are given below:

Measurements of specimens of Microtarsus atriceps abbotti.

[Collected by Dr. W. L. Abbott.]

U. S. N. M. number.	Sex.	Locality.	Date.	Total length. ²	Wing.	Tail.	Exposed culmen.	Tarsus.	Middle toe.
181549	Male....	Bawean Island ³ ...	Nov. 22, 1907	mm. 170	mm. 75	mm. 65	mm. 12	mm. 15.3	mm. 11.5
181550	Female..	.....do.....	.....do.....	180	80	68	12	14	11

Family TIMALIIDAE.

MALACOCINCLA ABBOTTI BAWEANA, new subspecies.

Subspecific characters.—Similar to *Malacocincla abbotti büttikoferi*,⁴ from Borneo, but upper parts paler, and, particularly, on tail and upper tail-coverts, even less rufescent; entire lower surface, especially the sides of breast and body, the flanks, and crissum, also lighter.

Description.—Type, adult male, No. 181560, U.S.N.M.; Bawean Island, Java Sea, November 23, 1907; Dr. W. L. Abbott. Upper surface brownish olive, between Saccardo's umber and light brownish olive, becoming somewhat darker on the pileum, where the feathers have pale buffy shaft streaks, and slightly more rufescent on the rump; upper tail-coverts cinnamon brown; rectrices between cinnamon brown and mummy brown; primaries, secondaries, and primary coverts brown, between olive brown and fuscous, their outer webs, together with both webs of tertials, greater, median, and lesser wing-coverts, brown like the back; lores and superciliary stripe between mouse gray and deep mouse gray, mixed more or less with pale mouse gray; remainder of sides of head and neck buffy brown, the auriculars somewhat streaked with the brown of the back, and with narrow and inconspicuous shaft markings of pale buffy; chin and throat grayish

¹ Oberholser, *Smiths. Misc. Coll.*, vol. 60, No. 7, October 26, 1912, p. 10.

² Measured in the flesh by the collector.

³ Type.

⁴ *Malacocincla büttikoferi* Finsch, *Notes Leyden Mus.*, vol. 22, March, 1901, p. 218. This is evidently but a subspecies of *Malacocincla abbotti*.

white, the latter buffy grayish on its sides; upper breast tiller buff; lower breast cream color, deepening on abdomen into pale ochraceous buff; crissum clay color; sides of breast dull buff, between pinkish buff and vinaceous buff, shaded anteriorly with the brown of the back; sides of body and flanks light buffy brown between cinnamon buff and wood brown; thighs between wood brown and drab; lining of wings dull buff like the sides of the body, mixed somewhat with pale brown and whitish; inner margins of outer secondaries and inner primaries dull vinaceous buff.

A second specimen obtained by Doctor Abbott is practically identical with the type. Both birds show indications of molt in wing-quills and contour feathers.

The present species is clearly distinct enough structurally from the typical forms of the genus *Turdinus* to be separated generically.

Measurements of specimens of Malaccocincla abbotti baweana.

[Collected by Dr. W. L. Abbott.]

U.S.N.M. number.	Sex.	Locality.	Date.	Total length. ¹	Wing.	Tail.	Exposed culmen.	Tarsus.	Middle toe
181500	Male.....	Bawean Island ²	Nov. 23, 1907	mm. 160	mm. 77	mm. 48.5	mm. 18	mm. 27.8	mm. 17.5
181559	...do.....	...do.....	Nov. 24, 1907	165	78.5	50	17.5	25.5	16.3

Family GRACULIDAE.

GRACULA JAVENSIS BAWEANA, new subspecies.

Subspecific characters.—Similar to *Gracula javensis javensis*, from Java, but bare occipital lappets wider and longer; and sides of crown more greenish.

Description.—Type, adult female, No. 181501, U.S.N.M.; Bawean Island, Java Sea, November 23, 1907; Dr. W. L. Abbott. Middle of forehead, middle of crown, with cervix and back, metallic dusky dull violet No. 2; sides of forehead the same, but somewhat tinged with greenish; sides of crown and sides of occiput metallic greenish, between dusky dull green and greenish slate black; rump and upper tail-coverts metallic dusky green; scapulars and tips of inner tertials metallic bluish slate black, in places with a tinge of the violet of the back; tail black, the outer rectrices somewhat brownish; wings black with a slight purplish or bluish sheen, some of the outer primaries a little brownish; a pure white speculum from 10 to 19 mm. in length occupies the entire width of the outer webs of the second to seventh

¹ Measured in the flesh by the collector.

² Type.

quills; another area varying from 4 to 28 mm. in length, on the inner webs of the first to seventh quills, covers the entire width of the vanes except on the seventh, where it is reduced to a small roundish spot close to the shaft; the lesser wing-coverts and broad edgings of the median series, metallic dull blue-green black; very narrow tips and subterminal edgings of greater coverts metallic dull violet like the back, or metallic bluish slate black like the scapulars; sides of head black, with a slight metallic greenish tinge; chin and throat black with a slight gloss of metallic violet, shading posteriorly on the jugulum into a metallic bronzy lincoln green; this in turn passing into metallic dark livid purple on the breast; thighs and sides of body metallic dull blue-green black, in places mixed with dull violet; flanks, abdomen, and crissum, metallic blackish dusky yellowish green; lining of wings black, in some places rather brownish, and mostly with a slight violet sheen.

Doctor Abbott obtained only two examples of this bird on Bawean Island, but these differ sufficiently from Javan birds to render their subspecific separation desirable. Their measurements are as follows:

Measurements of specimens of Gracula javensis baweana.

[Collected by Dr. W. L. Abbott.]

U.S.N.M. number.	Sex.	Locality.	Date.	Total length. ¹	Wing.	Tail.	Exposed culmen.	Height of bill at base.	Tarsus.	Middle toe.	Greatest length of lappet.	Greatest width of lappet.
181502		Bawean Island.....	Nov. 23, 1907	mm. 323	mm. 174.5	mm. 85	mm. 27	mm. 17	mm. 38.5	mm. 32	mm. 25	mm. 18
181501	♂	.....do. ².....	.....do.....	320	170	84	24.5	15.2	36.5	30	26	20

Family NECTARINIIDAE.

ANTHREPTES MALACENSIS BAWEANUS, new subspecies.

Subspecific characters.—Similar to *Anthreptes malacensis malacensis*, from the Malay Peninsula, but female more greenish (less grayish) above, the lower surface more richly and uniformly yellow, particularly on throat, abdomen, and crissum.

Description.—Type, adult male, No. 181590, U.S.N.M.; Bawean Island, Java Sea, November 19, 1907; Dr. W. L. Abbott. Pileum, cervix, and back, shining metallic amethyst violet, the forehead inclining to dark green; rump and upper tail-coverts shining metallic deep blue-violet; tail fuscous black, the middle pair of rectrices, and the outer webs of all the rest excepting the outermost pair, tinged

¹ Measured in the flesh by the collector.

² Type.

with metallic greenish and margined externally with shining metallic deep blue-violet; wings blackish fuscous (between fuscous and fuscous black), the inner margins basally paler, the wing-quills, greater coverts, and to a slight extent the primary coverts, margined externally with citrine; median coverts and longest scapulars chestnut; lesser coverts shining metallic blue-violet; sides of head between citrine and orange citrine; malar stripe, prolonged down the side of the neck, shining metallic violet ultramarine; sides of neck shining metallic dark green, mixed more or less with the amethyst violet of the back; chin and throat reddish brown, between kaiser brown and hazel; breast, sides, and upper abdomen lemon chrome, slightly inclining toward light cadmium, anteriorly somewhat tinged with brownish olive; lower abdomen and thighs picric yellow; lower tail-coverts pale lemon yellow; flanks, between lemon yellow and pyrite yellow, but much nearer the former, i. e., pale lemon yellow only washed with olivaceous; axillars picric yellow; under wing-coverts baryta yellow, mixed with whitish.

The male of this new form, as is frequently the case in races of *Anthreptes malacensis*, is not with certainty distinguishable, though it seems to be more clearly yellow on the breast than is usual in examples of *Anthreptes malacensis malacensis*. The female, however, shows differences, as above set forth, which apparently indicate subspecific distinction. Comparison has been made with series of specimens of all the forms of the species. Both of the individuals obtained by Doctor Abbott on Bawean Island are adults in perfect plumage, and their measurements are as follows:

Measurements of specimens of Anthreptes malacensis baweanus.

[Collected by Dr. W. L. Abbott.]

U.S.N.M. number.	Sex.	Locality.	Date.	Total length. ¹	Wing.	Tail.	Exposed culmen.	Tarsus.	Middle toe.
181590	Male....	Bawean Island ²	Nov. 19, 1907	mm. 142	mm. 68	mm. 48.5	mm. 17.8	mm. 17.8	mm. 10.5
181591	Female..	.....do.....	Nov. 25, 1907	130	63	41	15.2	16.5	10

CINNYRIS ORNATA ORNATA³ Lesson.

Cinnyris ornatus LESSON, Dict. Sci. Nat., vol. 50, 1827, p. 15 [Java].

One adult male, No. 181595, U.S.N.M., taken, November 22, 1907. Length (in flesh), 120 mm.

It is apparently identical with birds from Java. Some of the contour feathers are in process of molt.

¹ Measured in the flesh by the collector.

² Type.

³ For the change of name of this species from *Cinnyris pectoralis* Horsfield to *Cinnyris ornata* Lesson, see Oberholser, Smiths. Misc. Coll., vol. 60, No. 7, October 26, 1912, p. 18.

Family DICAÆIDÆ.

DICAÆUM FLAMMEUM (Sparman).

Motacilla flammea SPARRMAN, Mus. Carlson., fasc. 4, 1789, pl. 98 (Java).

One specimen, No. 181587, U.S.N.M.; taken, November 22, 1907.

Though marked "female," this bird is evidently a young male, since it is in transition from the juvenal plumage to that of the adult, and shows characteristic feathers of the male on head, back, and scapulars. As nearly as is possible to determine from such an example, it is identical with Javan birds. It can at least not be distinguished from a juvenal male from Java.

FIELD NOTES ON VIRGINIA ORTHOPTERA.

By HENRY FOX,

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INTRODUCTION.

The notes here recorded cover the period between December, 1913, and the close of 1915. During this time the writer was officially stationed at the field laboratory of his division at Charlottesville, where during the season of 1914 an almost continuous record of the local Orthoptera was kept. At intervals of variable duration the writer was away on field work in other parts of the State, the more important trips being to Norfolk and to Monterey, approximately a month being spent at each place. In 1915 practically the entire season was spent at Tappahannock. At all these places Orthoptera were studied as thoroughly as the time that could be spared for the purpose permitted. Fairly extensive collections were made at each of the localities mentioned. These along with smaller collections from a number of additional localities enable us to form at least a preliminary idea of the distribution of Orthoptera in relation to the different physiographic subdivisions of the State.

These as usually given in standard geographic works are five in number. Beginning at the east is the Coastal Plain, locally known as "Tidewater Virginia." This is limited on the west by the "fall line," beyond which the Piedmont region extends to the Blue Ridge which forms the third province. Then follows the Shenandoah or Valley of Virginia, the most fertile province of the State. West of this comes the succession of bold ridges and elevated intermontane valleys constituting the Appalachian Mountain province.

In central and southern Virginia each of these provinces presents certain peculiarities of physiography which apparently markedly influence the character of the respective floras and faunas. The greatest contrast is shown between the mountain section along the western border and the lower lands to the east. In the mountain section, as exemplified in Highland and Bath counties, we have the long, roughly parallel ridges and intermontane valleys typical of Appalachian country, with an elevation of from 1,500 to 4,500 feet.

Its fauna and flora are, on the whole, of a northern type, the dominant forms being those which are characteristic of southern New England or northern Pennsylvania. The Blue Ridge also shows some traces of northern influence, but its lower altitude (1,500–2,500 feet) and wide separation from the main Appalachian mass makes its fauna and flora less distinctive, many austral forms extending into it from the adjoining Piedmont. Observations in the Shenandoah Valley have been too meager to enable the writer to make any final assertions, but all signs indicate the transitional character of its biota. In the Piedmont region as shown at least in the latitude of Charlottesville two sections can be distinguished. That bordering the Blue Ridge, which we may speak of as the Upper Piedmont, is considerably more rugged and diversified than the section farther east, which is nearly flat or at most gently rolling. In general the line of the Chesapeake & Ohio Railroad between Gordonsville and Orange marks the boundary between these two sections. In the upper section the fauna and flora are predominantly austral in character, but there is also a considerable infusion of northern elements. The lower section has so far been but little studied by the writer, but the vegetation at least shows an influx of certain Coastal Plain elements which apparently do not occur in the upper section. Thus in the region immediately east of Gordonsville occur such trees as sweet gum (*Liquidambar styraciflua*) and willow oak (*Quercus phellos*) which do not appear to exist in the more rugged country about Charlottesville. Farther east the line of demarkation between the Piedmont and Coastal Plain is clearly indicated only along the large rivers where the usual falls occur, but elsewhere the transition from the one to the other is gradual. This is a decided contrast to the abrupt passage between the two in the Pennsylvania-New Jersey region where the fall-line marks a decided break in both topography and biota. In Virginia no such break occurs, the typical Coastal Plain elements spreading inland to a varying extent, some, such as the loblolly pine (*Pinus taeda*) and the holly (*Ilex opaca*) extending only a dozen or so miles west of the fall line, others, like the sweet gum and willow oak, to the western limit of the lower Piedmont, while such trees as the Spanish oak (*Quercus falcata*) and persimmon (*Diospyros virginiana*) spread clear across the entire Piedmont to the base of the Blue Ridge.

In Virginia the Coastal Plain presents certain well-marked contrasts to the same province as represented farther north in New Jersey. In general, it may be said that the soil, although prevailingly sandy, is of a decidedly finer texture than the New Jersey sands and is consequently more suitable for cultivation. In Virginia nothing comparable to the New Jersey pine barrens has so far been observed, the country on the whole having much the same appearance as the

Delaware Valley district of that State.¹ South of the James River the Coastal Plain, appears to be largely a flat, or at most, gently rolling, featureless expanse, but north of that river in the narrow peninsulas between the estuaries of the York, Rappahannock, and Potomac rivers there is some quite rugged topography in places where the small streams have cut deep ravines in the upland. Bordering all the large rivers in the Coastal Plain are wide, level terraces marking an earlier stage of flood-plain deposition [Columbian formation]. The boundary between these "flats" and the higher interior is formed by a well-defined line of bluffs.

With regard to its Orthopteran fauna there appears to be in Virginia two primary centers of dispersal, one of which is typically represented by the Appalachian Province, the other by the Coastal Plain. The Appalachian Province is the center of an assemblage of decided northern affinities, certain members of which tend to spread eastward into the Piedmont region and, to a less degree, into the Coastal Plain. The latter province forms the center of a southern or Austral fauna, similar in its essential features to the Coastal² fauna of New Jersey, which in Virginia spreads in large measure over the entire Piedmont region and to a certain degree penetrates the Blue Ridge and lower mountain levels.

Typical of the Appalachian Province, in Virginia appear to be the following:

Orphulella speciosa.
Chloealtis conspersa.
Chorthippus curtipennis.
Encoptolophus sordidus.
Camnula pellucida.
Pardalophora apiculata.
Spharagemon saxatile.
Dendrotettix australis.
Melanoplus celatus.
Melanoplus devius.
Melanoplus gracilis.

Melanoplus walshii.
Melanoplus femur-rubrum.³
Melanoplus confusus.
Melanoplus luridus.
Melanoplus bivittatus.
Scudderia pistillata.
Amblycorypha rotundifolia.
Neoconocephalus ensiger.
Conocephalus brevipennis.³
Atlanticus davisi.

Other forms occurring commonly in the mountains, but of approximately equal frequency and uniformity throughout the State are *Arphia sulphurea*, *Chorthippa viridifasciata*, *Spharagemon bolli*, *Dissosteira carolina*, *Scudderia texensis*, *Scudderia furcata*, *Orchelimum vulgare*, *Conocephalus fasciatus* (apparently more uniformly

¹ See Stone, Plants of Southern New Jersey, Annual Report, N. J. State Museum, Trenton, N. J., 1910.

² See Fox, Data on the Orthopteran Faunistics of Eastern Pennsylvania and Southern New Jersey, Proc. Acad. Nat. Sci., Phila., 1914, pp. 457-463.

³ Both *M. femur-rubrum* and *C. brevipennis* occur throughout the State, but in the writer's experience they are much more abundant and generally distributed in the mountain section than in the Piedmont region and Coastal Plain where they are usually quite local in distribution, though quite common in favorable situations. The writer wishes it understood that he does not mean to imply that the forms listed above are necessarily Appalachian in origin, merely that, as conditions are at present, the species have their stronghold in the region in question.

distributed in the Coastal Plain), *Conocephalus strictus* (?) and *Nemobius fasciatus*.

Species having their stronghold in the Coastal Plain appear to be the following:

Doru aculeatum.
Stagmomantis carolina.
Truxalis brevicornis.
Mermeria intertexta.
Syrbula admirabilis.
Amblytropidia occidentalis.
Orphulella pelidna.
Orphulella olivacea.
Climacophorus elegans.
Dichromorpha viridis.
Arphia xanthoptera (?).
Pardalophora phoenicoptera.
Hippiscus rugosus.
Psitidia fenestralis.
Trimerotropis citrina.
Trimerotropis maritima.
Leptysma marginicollis.
Schistocerca serialis.
Schistocerca damnifica.
Schistocerca alutacea.
Schistocerca obscura.
Melanoplus scudderi.
Melanoplus atlantis.
Melanoplus keeleri.
Paroxya clavuliger.
Scudderella cuneata.

Amblycorypha floridana carinata.
Amblycorypha uhleri.
Neoconocephalus exilis canorus.
Neoconocephalus lyristes.
Neoconocephalus melanorhinus.
Neoconocephalus robustus.
Neoconocephalus palustris.
Neoconocephalus retusus.
Neoconocephalus triops.
Orchelimum agile.
Orchelimum glaberrimum.
Orchelimum laticauda.
Orchelimum concinnum.
Orchelimum minor.
Orchelimum fidicinium.
Orchelimum superbum.
Conocephalus stictomerus.
Conocephalus nigropleuroides.
Conocephalus spartinae.
Conocephalus saltans.
Atlanticus americanus.
Anurogryllus muticus.
Anaxipha exigua.
Apithes agitator.
Orocharis saltator.

At Charlottesville in the upper Piedmont country the following Appalachian forms have been taken:

Orphulella speciosa.
Pardalophora apiculata.
Melanoplus femur-rubrum.
Melanoplus confusus.

Melanoplus luridus.
Melanoplus bivittatus.
Conocephalus brevipennis.

At the same locality the following Austral types have been obtained.

Syrbula admirabilis.
Orphulella pelidna.
Dichromorpha viridis.
Arphia xanthoptera.
Pardalophora phoenicoptera.
Hippiscus rugosus.
Schistocerca serialis.
Schistocerca damnifica.
Schistocerca alutacea.
Melanoplus scudderi.

Melanoplus atlantis.
Paroxya clavuliger.
Amblycorypha floridana carinata.
Amblycorypha uhleri.
Neoconocephalus robustus.
Neoconocephalus retusus.
Neoconocephalus triops.
Orchelimum agile.
Conocephalus saltans.
Anurogryllus muticus.

It is evident from these lists that the affinities of the Charlottesville region are fundamentally Austral, but that intermixed with the Aus-

tral types is a small number of Appalachian forms. Of the latter the only representatives that are at all common are spring or early summer species, such as *Melanoplus confusus* and *Pardalophora apiculata*, or widely distributed forms, which, nevertheless appear to have their stronghold in the Appalachian region, such as *Melanoplus femurrubrum*.

The Blue Ridge has not been sufficiently studied to enable us to form an adequate idea of its Orthopteran fauna, but so far the following Appalachian species have been obtained at the two localities visited:

Orphulella speciosa.

Chloaltis conspersa.

Pardalophora apiculata.

Spharagemon saxatile.

Melanoplus celatus.

Melanoplus confusus.

Melanoplus bivittatus.

Melanoplus luridus.

Amblycorypha rotundifolia.

With these are associated the following Austral forms:

Dichromorpha viridis.

Pardalophora phoenicoptera.

Hippiscus rugosus.

Melanoplus atlanis.

Parozya clavuliger.

The localities in the State where collections or observations were made include the following:

COASTAL PLAIN.

Norfolk, Portsmouth, Churchland, Gilmerton, and Deep Creek, Norfolk County, and Deanes, Nansemond County, August 8–10, September 15 to October 8, 1914; April 17–19, May 31, July 11, 1915. Altitude 10 to 20 feet. Country a nearly flat plain intersected by numerous tidal inlets and "branches." Soils prevailingly sands or sandy loams of fine texture.

Virginia Beach, Princess Anne County, August 9, September 20, 1914. Altitude, 20 feet. A typical beach of coarse beach sand, back of which are low dunes bordered on the landward side by higher, rolling fixed dunes occupied by loblolly pine and other trees, these merging into the ordinary inland region.

Cape Henry, Princess Anne County, September 20, 27, 1914. Altitude, 50 feet. Region essentially like the preceding, but with higher sand dunes.

Franklin, Southampton County, September 18, November 5, 1914. Altitude, about 60 feet. Topography flat to gently rolling. Soils sandy loams of fine texture.

Tappahannock, Essex County, November 9–12, 1914; April 20 to May 4, May 26 to October 24, 1915. Altitude, about 50 feet. Topography consisting of nearly flat plains bordering river (Columbia formation) and level to locally rugged uplands. Soils variable, but usually sandy and of fine texture, frequently silty; rarely coarse or gravelly.

Center Cross, Essex County, August 18, 1915. Altitude, about 100 feet. Topography level to gently rolling, similar to the upland country surrounding the preceding locality.

Dunnsville, Essex County, April 24, August 18, October 3, 1915. Similar to the preceding.

Ware's Wharf, Essex County, October 3, 1915. Altitude, below 50 feet. Low, flat terrace lands bordering river.

Mt. Landing, Essex County, April 28, 1915. Altitude, about 150 feet. Similar to region about Center Cross.

Lloyds, Essex County, April 28, 1915. Altitude, about 150 feet. Similar to the preceding.

Naylors, Richmond County, September 17, 1915. Low, sandy flats and marshes bordering river (Columbia formation).¹

Sharps, Richmond County, November 13-14, 1914; May 4-26, June 21-23, October 13-15, 1915. Altitude from below 50 feet to about 150 feet. Broad, nearly level plain adjoining river (Columbia formation), with higher level to slightly rolling uplands, with occasional steep slopes close to streams, from 4 to 6 miles back from river. Soils fine-textured, varying from light sandy loams to stiff silty clays.

Urbanna, Middlesex County, August 18, 1915. Altitude, about 100 feet. Level to slightly hilly upland. Soils fine sandy loams.

Millenbeck, Lancaster County, August 8, September 27, 1915. Altitude below 50 feet. Sandy and marshy beach and flat sandy terrace-plains.

Ottoman, Lancaster County, August 8, September 27, 1915. Altitude below 50 feet. Topography, flat. Soils fine sands to stiff silty clays.

Irvington, Lancaster County, September 26, 1915. Altitude below 50 feet. Topography, flat or very gently rolling. Soils fine sandy loams.

Whitestone, Lancaster County, September 26, 1915. Altitude below 50 feet. Sandy beach and salt marshes along river; elevated level terrace elsewhere.

Newtown, King and Queen County, August 17, 1915. Altitude about 150 feet. Topography undulating. Soils mostly fine sandy loams.

PIEDMONT REGION.

Fredericksburg, Spotsylvania County, September 5, 1915. Altitude, 150 to 200 feet. Topography rolling to hilly. Soils, so far as observed, sandy loams.

Warrenton, Fauquier County, June 8, 1914. Altitude, 400 to 600 feet. Topography, gently rolling. Soils not studied, but apparently sandy loams predominate.

¹ See Fredericksburg Folio, U. S. Geol. Survey.

Louisa, Louisa County, October 26, 1914. Altitude, 500 feet. Topography, gently rolling. Soils consisting of sandy loams and stiff red clays.

Bells Cross Roads, Louisa County, October 26, 1914. Altitude, 500 feet. Topography gently undulating, with moderately steep slopes near the streams. Soil mostly sandy loams with stiff, red clay subsoil.

Republican Grove, Halifax County, November 2, 1914. Altitude, about 500 feet. Topography, flat to gently rolling. Soil, a sandy loam, underlaid by stiff, buff-colored subsoil.

Charlottesville, Albemarle County, December 1, 1913, to August 14, 1914, September 9–14, October 9 to November 1, November 15, 1914, to April 15, 1915; October 27 to December 1, 1915. Altitude, 300 to 800 feet. Topography varied, but as a rule fairly rugged, with steep slopes near streams, but with more or less extensive level or slightly rolling interstream areas. Soils, sandy loams and stiff red clays.

Carter's Mountain, Albemarle County, February 22, October 31, 1915. Altitude, 800 to 1,300 feet, a prominent ridge of Catoclin schist, 2 miles southeast of Charlottesville. Soil a mellow, reddish clay (Porters clay).

Crozet, Albemarle County, August 1, 1914. Altitude, 700 feet. Topography rolling.

BLUE RIDGE.

Rock Fish Gap, near Afton, Albemarle County, May 30, 1914. Altitude, about 2,000 feet. Topography steep and rugged. Soil, a mellow, brown loam, more or less stony.

Jarman's Gap, Albemarle County, 4 or 5 miles west of Crozet. July 30 to August 1, 1914. Altitude, 2,500 feet. Topography and soils similar to preceding.

SHENANDOAH VALLEY.

Front Royal, Warren County, June 9, 1914. Altitude, 500 to 600 feet. Surface, a gently rolling upland with steep slopes close to the streams.

Woodstock, Shenandoah County, June 10, 1914. Altitude, 800 to 900 feet. Topography, gently rolling. Soil, a rich clay loam (Hagerstown series).

Dale Enterprise, Rockingham County, June 11, 1914. Altitude, 1,300 to 1,400 feet. Topography, rolling to hilly. Soil, a rich, clay loam.

Fishersville, Augusta County, June 12, 1914. Altitude, 1,400 feet. Topography, rolling to hilly. Soil, a rich clay loam, stony on steeper slopes.

APPALACHIAN PROVINCE.

Bells Valley, Rockbridge County, April 15, 1915. Altitude, 1,600 feet. Topography, rolling; a valley bordered on each side by high mountain ridges. Soil, a rich clay loam, more or less stony.

Hot Springs, Bath County, September 5-7, 1914. Altitude, 2,300 to 3,500 feet. Topography of usual Appalachian type with rolling intermontane valley and steep mountain ridges. Soil, a clay loam, stony on mountains.

Bolar, Highland County, August 15 to September 3, 1914. Altitude, 2,200 to 2,500 feet. Topography rugged; a narrow intermontane valley and steep mountain ridges, with rather wide alluvial flats along stream. Soils, loamy, stony on slopes.

Trimble, Highland County, August 15 to September 2, 1914. Altitude, 2,600 feet. Narrow stream valley with border meadows and steep mountain ridges. Soils, loamy.

Meadowdale, Highland County, August 19, 1914. Altitude, 2,800 to 3,000 feet. A narrow intermontane valley, bordered by steep mountain ridges. Soils, mostly rich clay loams.

Monterey, Highland County, August 15 to September 4, 1914. Altitude, 2,800 to 4,000 feet. Topography of typical Appalachian type consisting of intermontane valley bordered on each side by mountain ridges. Soil, a rich, mellow clay loam in valley; a thin, stiff rocky clay on steeper slopes.

Sounding Knob, Highland County, September 1, 1914. Altitude, 4,500 feet. A prominent peak, 6 miles south of Monterey.

SYSTEMATIC LIST OF SPECIES.

Family FORFICULIDAE.

DORU ACULEATUM (Scudder).

Tappahannock, July 28 to September 10, 11 males, 6 females. Evidently frequent on tall reeds, *Spartina cynosuroides*, in tidal marshes, occasionally spreading to nearby timothy pastures (August 21, 1 male, 1 female). Active only at night.

Family BLATTIDAE.

ISCHNOPTERA, species.

A fair number of roaches of this genus were obtained at Charlottesville and Tappahannock. They are at present in the care of Mr. Morgan Hebard, who is engaged in a revision of the genus.

CRYPTOCERCUS PUNCTULATUS Scudder.¹

Hot Springs, September 7, 1 male; Monterey, between August 20 and September 1, 1 male.

¹ I am indebted to Mr. Rehn for this determination.

Family MANTIDAE.

STAGMOMANTIS CAROLINA (Johannsen).

Tappahannock, September 6 to 19, 3 males, 3 females; Naylor's, September 17, 1 male. Apparently a denizen of marshes, showing a preference for areas of tall reeds, *Spartina cynosuroides*, but also occurring in grassy (*Homalocenchrus oryzoides*, *Sagittaria*, etc.) inland bogs and occasionally straying to thickets on the adjoining dry land.

Family ACRIDIIDAE.

Subfamily TETTIGINAE.

ACRYDIUM (TETTIX) ARENOSUM ANGUSTUM (Hancock).¹

Tappahannock, April 22–30, 3 males, 4 females.

Charlottesville, March 28, April 12–22, May 1, 25, 31, June 15, July 4, 1914. Locally frequent, showing a marked preference for patches of bare, damp earth, occurring in open woodland and in open, grassy pastures.

Jarman's Gap, August 1, 1914, 1 female.

NEOTETTIX FEMORATUS (Scudder) (= *N. bolivari* Hancock).²

Tappahannock, September 9, 1 male.

Charlottesville, May 18, 1 male, June 27, 1 female, 28, 1 male, July 3–17, 1 male, 3 females. Occasional, preferring areas of damp or relatively firm ground, either bare or covered with short grasses, in pastures and stream bottoms.

TETTIGIDEA LATERALIS (Say)

Virginia Beach, September 20, 1 female. Occasional in open grove of pine (*P. taeda*) and sweet gum on fixed dunes; Tappahannock, April 23, 1 female.

Charlottesville, April 12, 17, 19, 22, May 19, 31, June 17, 20, 25, July 4, 8, 11, 17, September 10, 1914. Common, but somewhat local, having the same general habitat preferences as the other tettigids, occurring in both woodland and campestrial locations.

Monterey, September 1, 1914, 1 male. (Dry, open woods on mountain slope.)

Subfamily TRUXALINAE.

TRUXALIS BREVICORNIS (Johannsen).

Churchland, September 16, 2 males (in thick growth of goose grass, *Eleusine indica* in low, sandy field adjoining "branch"). Tappahannock, August 2, 2 males, 1 female juv., August 10 1 female juv.,

¹ Typical specimens determined by Mr. Hebard.

² Determinations by Mr. Hebard.

August 12, 1 male, August 13 to September 19. Frequent in tidal marshes, occurring especially in growths of *Scirpus americanus* and to a less extent in *Spartina cynosuroides*, also occurring in grassy inland bog and in vegetation bordering mill pond; Naylors, September 17, 2 females (occasional in *Scirpus americanus* patches of tidal marsh); Wares Wharf, October 3, 1 female (tidal marsh in zone occupied by *Spartina cynosuroides* and *Baccharis halimifolia*); Whitestone, September 26, 2 males, 1 female (in patch of cat-tails).

Fredericksburg, September 5, 1 female (low damp spot, corner of woods, in area occupied by ironweed, boneset, and associated vegetation).

MERMIRIA INTERTEXTA Scudder.¹

Portsmouth, October 3, 2 males, 1 female (in bunch grasses (*Andropogon*, *Sorghastrum*), of open oak and sweet gum scrub bordering tidal marshes); Millenbeck, August 8, September 27 (several in thick grass (*Spartina patens*) and bushes (*Iva oraria*), bordering patch of tall *Spartina glabra* on shore of estuary); Whitestone, September 26, 2 females (edge of salt marsh, in zone of *Spartina glabra*, *Distichlis spicata*, and *Baccharis*).

SYRBULA ADMIRABILIS (Uhler).

Norfolk, July 11, juv.; Churchland, August 8-9, adults and juv., September 15; July 11, 1915, juv. only; Deanes, September 26; Gilmerton, October 1, November 6; Deep Creek, October 1; Franklin, September 18, November 5; Tappahannock, June 4 to July 18, nymphs only; July 25 to August 2, adults and nymphs; August 13 to October 11; Wares Wharf, October 3, 1 female; Center Cross, August 18; Sharps, June 22, juv., October 13, 1 female; Urbanna, August 18; Ottoman, August 8, September 27; Irvington, September 26, 1 female; Newtown, August 17.

Fredericksburg, September 5; Charlottesville, May 23 to July 22, nymphs only, July 31 to August 12, adults and nymphs, September 10 to October 16, 1914; October 30, 1915.

A frequent and widely distributed species in old, neglected fields and pastures, especially those overgrown with *Andropogon* and other coarse and dry grasses, less commonly found in open woodland scrub. Apparently of equal frequency throughout the Piedmont and Coastal Plain provinces.

ERITETIX SIMPLEX (Scudder) [= *E. carinatus* of authors].

Tappahannock, April 24-29, June 4-8, September 19 to October 11 (nymphs); Mount Landing, April 28; Lloyds, April 28; Dunnsville,

¹ Determined by comparison with material in collection of the Academy of Natural Sciences of Philadelphia. The species called *vigilans* in my paper on New Jersey Orthoptera (Proc. Acad. Nat. Sci., Phila., vol. 66, 1914, p. 487) is the same, *vigilans* now being recognized, according to Rehn (verbal communication) as a synonym of *intertexta*.

April 24; Center Cross, August 18 (nymphs); Sharps, May 5-18, June 22; Ottoman, September 27 (nymphs); Irvington, September 26 (nymphs).

Bells Cross Roads, October 26 (nymphs); Charlottesville, December 5, 1913 (nymphs), March 23 to April 17 (nymphs), April 19-26 (adult males, nymphs), May 1 (adult male, female, and nymphs), May 9 to June 25, June 27-28 (adults and recently hatched young), July 3 to November 26, 1914 (nymphs), February 21 to April 4 (nymphs), April 6-8 (adult male, nymphs), October 27 to November 20, 1915 (nymphs).

Bells Valley, April 15, 1915 (1 juv.).

Frequent in old, neglected fields and pastures, especially those over run with *Andropogon* and other coarse grasses, in the Piedmont region and part of the Coastal Plain, but not yet taken in the southeastern portion of the State. Nothing definite can be said regarding its westward range in the State since collections from the Appalachian region are lacking for the season when the species is most common, except for the single immature example taken in Bells Valley as noted above.

In Virginia this species occurs in two forms. One of these, representing the typical race, is characterized by the possession of a pair of supplementary carinae on the disk of the pronotum between the median and lateral carinae, and by the presence of a pair of longitudinal black lines bordering the lateral carinae on their inner sides. The other or atypical race (see Rehn and Hebard, Proc. Acad. Nat. Sci., Phila., vol. 62, 1911, pp. 626-627) lacks both of these features, but has instead a unicolorous pronotal disk and a broad bar of brown on the sides of the pronotum below the lateral carinae. Both forms are frequent at Charlottesville and in the Rappahannock River valley, the typical form being the more abundant, though the atypical form is by no means scarce. Both have the same habitat preferences and life histories, and are almost invariably associated with each other. Although typical examples of both races are common, the writer has never found any individuals bridging the gap between them. If such intergradations exist they are apparently very exceptional.

AMELYTROPIDIA OCCIDENTALIS (Saunders).

Deanes, September 26, 1 male, 1 juv.; Gilmerton, November 7, 1 female.

Known only from the extreme southeastern portion of the State, where it appears to be very scarce. Those taken by the writer were found in the low grassy undergrowth of open woodlands of oak, loblolly pine, and sweet gum.

65008°—Proc. N.M. vol. 52—17—14

ORPHULELLA SPECIOSA (Scudder).

Charlottesville, July 1-31, 6 males, 9 females (infrequent, local).

Jarman's Gap, July 30, August 1, 3 males, 1 female.

Monterey, August 17 to September 1 (common); Hot Springs, September 6-7 (occasional).

This species was quite common in the drier, closely-grazed pastures and open mountain slopes about Monterey; at Hot Springs it appeared to be much less frequent, though more extended search might have shown it more abundant. At Charlottesville, it appeared to be rather scarce, occurring in noticeably smaller numbers than its congener, *O. pelidna*, with which it was usually found associated in dry upland and hillside pastures.

ORPHULELLA PELIDNA (Burmester).

Norfolk, September 17, 1914, July 11, 1915; Portsmouth, October 3; Churchland, August 8-9, September 15-16, November 4, 1914, July 11, 1915; Deanes, September 26; Gilmerton, October 1, November 6; Deep Creek, October 1; Virginia Beach, August 9, September 20; Cape Henry, September 27; Franklin, September 18, November 5; Tappahannock, June 4-20 (nymphs), June 30-October 24; Center Cross, August 18; Urbanna, August 18; Naylor's, September 17; Sharps, June 22 (adults and nymphs), October 13; Ottoman, August 8, September 27; Irvington, September 26; Newtown, August 17.

Fredericksburg, September 5, Charlottesville, June 13-15 (nymphs) June 27 (1 male, nymphs), July 8 (6 males, 4 females, 1 juv.); July 11 to August 12, 1914.

One of the most common and widely distributed species of the Coastal Plain, extending into the Piedmont as far, at least, as Charlottesville, where it is rather frequent, although of somewhat local occurrence. Its usual preference is for open fields and pastures over-run with *Andropogon* and other dry grasses, but is also not uncommon in the grassy and herbaceous undergrowth of open woodlands and in the low grassy tracts adjoining tidal marshes.

ORPHULELLA OLIVACEA Morse.

Wares Wharf, October 3, 1 female (tidal marsh, zone of *Spartina patens*, *Iva oraria*, etc.), 1 male 1 female (marshy river shore, in *Spartina glabra*); Naylor's, September 17, 1 female (tidal marsh, in *Scirpus americanus*); Millenbeck, August 8, September 27 (frequent in *Spartina glabra* and border fringe of *S. patens* on marshy shore of estuary); Whitestone, September 26 (common in salt marsh).

This being a strictly maritime species is naturally confined to tide-water Virginia. It is evidently common in suitable situations in the lowest part of the Rappahannock River where the water has a fairly high salt content and where the typical salt marsh grass, *Spartina*

glabra, is abundant, but farther up the basin, as in the vicinity of Tappahannock, where the water is only slightly brackish, and the tidal marshes occupied mostly by *Scirpus americanus* to the almost total exclusion of *Spartina glabra*, it apparently becomes quite scarce.

CLINOCEPHALUS ELEGANS Morse.

Norfolk, September 17, 1914, July 11, 1915 (nymphs); Portsmouth, October 3; Cape Henry, September 20; Tappahannock, July 25 to October 11; Wares Wharf, October 3; Naylor's, September 17; Sharps, October 13.

This species, in spite of its usual occurrence within the range of tidal influence, is not a true maritime form. Its favorite haunts are the low damp or marshy tracts forming the border zones of tidal marshes where fresh water prevails, and where the species shows a marked preference for the somewhat restricted areas occupied by *Distichlis spicata*, but also occurs in somewhat smaller numbers in the more extensive areas of *Scirpus americanus* and *Spartina patens* and much less frequently in the tall reeds, *Spartina cynosuroides*. In true salt marsh—namely, that occupied by *S. glabra*—it does not normally occur. Occasionally it is taken in inland localities; thus, at Tappahannock two adult females were observed in a grassy, fresh-water bog fully 4 miles from the river. The dominant growth in this bog consisted of *Homalocenchrus oryzoides*, with which were intermixed numerous plants of *Sagittaria* and *Pontederia*.

DICHROMORPHA VIRIDIS (Scudder).

Franklin, September 18 (very local, apparently not common); Tappahannock, June 30 (nymphs), July 18 to October 11 (of frequent occurrence, though somewhat sporadic); Naylor's, September 17 (occasional); Sharps, October 13 (apparently local); Irvington, September 26, (1 female).

Fredericksburg, September 5 (1 male); Charlottesville, June 25–28 (nymphs), July 3 (male, nymphs), July 8–22 (male, female, nymphs), July 27 to October 31, 1914 (frequent, but rather sporadic).

Jarmans Gap, July 30 (several adults).

This species appears to be very local in southeastern Virginia; in other portions of the Coastal Plain and Piedmont region visited by the writer it was of very regular though somewhat sporadic occurrence. Its haunts in this region are somewhat varied, but are usually in damp spots or, if in dry situations, in places where excessive evaporation is prevented by a tolerably thick cover of vegetation. As noted by Morse, it is intermediate in its habitats between campestral and sylvan types. In open country the writer has observed it in such situations as areas of tender grass in shallow gulleys; in damp depressions harboring such plants as *Juncus effusus*, alder bushes,

ironweeds and their usual associates; in closely grazed grassy pastures on stiff soil; in dense clumps of *Andropogon* on dry, but compact soils; grassy meadows bordering streams; and grassy tracts bordering fresh and tidal marshes, but, in the case of the latter, it apparently never occurs in areas lying within the direct influence of the tides. In no case has the writer ever found this species associated with *Clinocephalus* in the *Distichlis spicata* areas, though occurring only a few yards away in the dark green, tender grasses and sedges occupying the ditches and other humid tracts of the adjoining forelands. In open woodland the species has been regularly taken in wet or damp grassy spots and not infrequently also in relatively dry, shrubby undergrowth. In general, the writer's observations indicate that the young are largely, if not entirely, restricted to moist or somewhat damp situations, and that the adults tend to spread from these into the dryer locations.

CHLOEALIS CONSPERSA Harris.

Jarmans Gap, August 1, 2-2 males, 6 females.

Hot Springs, September 5-6, 2 males, 1 female; Bolar, September 3, 1 male, 1 female; Monterey, August 18-September 1 (sporadic, not infrequent).

Observations so far made indicate that this species is confined to the mountainous regions of the State.¹ All species were taken in situations typical of the species, namely, in open deciduous woodlands, where they occurred in grassy or shrubby undergrowth, in both moist and dry stations. One example from Bolar, however, was taken on a road crossing the wide, nearly level meadows of the Jackson River Valley.

CHORTHIPPUS (-STENOBOTHRUS) CURTIPENNIS (Harris).

Bolar, August 15, September 3; Meadowdale, August 19; Monterey, August 16 to September 1.

The writer found this one of the commonest grasshoppers in the high, intermontane valleys of Highland County. It is evidently confined to the mountain districts. Its favorite haunts are the open moist depressions and ditches overgrown with dense, succulent grasses and other herbage (ironweed, boneset, joe-pye weed, *Juncus effusus*, smartweed); from these it spreads in considerable numbers to the neighboring meadows, pastures, and mountain slopes, but rarely, if ever, invades wooded tracts.

Subfamily OEDIPODINAE.

ARPHIA SULPHUREA (Fabricius).

Churchland, July 11, 2 males; Franklin, September 18 (nymph); Tappahannock, April 25 (adult male, juv.), April 29 to July 25; Lloyds, April 28 (2 males, 1 juv.); Sharps, May 18-23, June 22.

¹ Mr. Rehn informs me it has been taken at Arlington.

Charlottesville, March 23 to April 19 (nymphs), April 26 to May 3 (male, juv.), May 17 to July 3, September 10 to October 31, 1914 (nymphs), February 21, 1915 (nymphs).

Rock Fish Pass (Afton), May 30; Jarmans Gap, July 30, 1 female, August 1, 1 male, 1 female.

Woodstock, June 10; Fishersville, June 12.

Monterey, August 22, 1 female.

Occasional, or at most sporadically frequent, in *Andropogon* and other coarse grasses of dry, untilled areas in or near woodland, rarely in open pastures of tender grass. Apparently uniformly frequent throughout the State, the data on this point from the mountain section being, however, inconclusive as yet owing to the lateness of the season at which observations were made, when only the last few survivors of this species were to be found.

ARPHIA XANTHOPTERA (Barmelater).

Portsmouth, October 3; Churchland, September 15 to October 1, November 4; Deanes, September 26; Gilmerton, October 1, November 6; Deep Creek, October 1; Virginia Beach, September 20; Franklin, September 18, November 5; Tappahannock, July 25 (juv.), August 2-21 (adult male and juv.), September 9 to October 11; Wares Wharf, October 3; Naylor's, September 17.

Fredericksburg, September 5; Charlottesville, June 25 to July 8 (juv.), July 31 to October 31, 1914.

Monterey, August 31, 1 female; Trimble, September 2, 1 female; Hot Springs, September 6-7.

Moderately frequent in most localities visited, but apparently quite scarce in Highland County, and even somewhat local in the Rappahannock River section of tidewater Virginia where it was not observed in a number of localities—a fact that indicates, as borne out by continuous observations at Charlottesville, Tappahannock, and Norfolk, the sporadic occurrence of the species in contrast to the general distribution of such common forms as *Melanoplus atlantis*, *Orphulella pelidna*, etc.

In a general way *xanthoptera* shows greater latitude in its choice of habitats than *sulphurea*. Both are dry land forms and flourish only in untilled areas, but *xanthoptera* does not show any marked preferences for woodland associations, occurring as frequently in campestral stations as in sylvan. In open country it usually occurs in old waste fields and pastures overrun with coarse grasses and weeds, and the grassy tangles bordering cultivated fields; in woodland surroundings it frequents the low, briery scrub and coarse herbage of clearings and borders.

CHORTOPHAGA VIRIDIFASCIATA (De Geer).

Norfolk, September 17, 1914 (adults and juv.), April 19 (adults, male and female, frequent), July 11, 1915 (male, still soft); Churchland, August 8-9, September 15 to October 3, November 4 (nymphs), 1914, April 17 (1 female, 1 juv.), May 31 (1 female), 1915; Deanes, September 26; Gilmerton, November 6 (juv.); Virginia Beach, September 20; Franklin, September 18 (adults and nymphs); Tappahannock, April 20 to July 1, July 18 to October 24 (adults and nymphs); Mount Landing, April 28; Lloyds, April 28; Dunnsville, April 24; Center Cross, August 18; Urbanna, August 18; Sharps, November 13 (nymphs), 1914, May 5-23, June 22, 1915; Ottoman, August 8; Irvington, September 26 (nymphs).

Fredericksburg, September 5 (adults and nymphs); Warrenton, June 8; Bells Cross Roads, October 26 (adult male, nymphs); Republican Grove, November 2; Charlottesville, December 5, 1913 (nymphs); March 23 to April 10 (nymphs), April 12 to May 9 (adults and nymphs), May 17 to June 20, June 25 to November 26 (adults and nymphs), 1914, February 15 to April 1 (nymphs); April 4-8 (adults, male and nymphs), October 27 to November 25 (adults and nymphs), 1915.

Jarman's Gap, July 30, August 1 (adults and nymphs); Rock Fish Pass (Afton), May 30.

Front Royal, June 9; Woodstock, June 10; Dale Enterprise, June 11; Fishersville, June 12.

Bells Valley, April 15 (adult males, and nymphs); Monterey, August 16 to September 1 (adults and nymphs); Meadowdale, August 19 (nymphs); Hot Springs, September 6-7 (nymphs).

This is the most generally and uniformly distributed grasshopper of the State, so far as collections from the localities listed enable one to judge. In numerical strength its only superiors are the dominant species of *Melanophus*, namely, *M. atlantis* in the Coastal Plain and Piedmont sections and *M. femur-rubrum* in the Appalachians. It occurs in a great variety of habitats, but shows a stronger predilection for campestral stations than for sylvan surroundings. It is common in cultivated fields (wheat plats, clover, and timothy pastures, etc.) as well as old waste lots and pastures.

The winter is passed in the nymph stage. At Charlottesville the earliest adult males were found April 4 (1915), the earliest females April 12 (1914). The eggs laid by the spring brood of adults begin to hatch toward the end of June (June 25, 1914) and adults of the second brood first appear by the middle (July 11, Norfolk) or end (July 20, Charlottesville) of July. Adults of this brood continue to develop during the remainder of the summer and early autumn, and survive until the beginning of winter. It is possible that the earliest maturing individuals of second generation may lay eggs from which hatch the smaller of the winter-surviving nymphs, but this point needs experimental verification before it can be accepted as a fact.

ENCOPTOLOPHUS SORDIDUS (Burmeister).

Monterey, August 17 to September 1, 1914; Meadowdale, August 19, 1914; Hot Springs, September 7, 1914.

One of the most abundant grasshoppers in the drier timothy and blue-grass pastures of the high, intermontane valleys and mountain slopes of Highland and Bath Counties. The writer has not taken it outside of the mountains, but Morse¹ records it from Roanoke and Rehn informs me that it occurs as far east as Fredericksburg.

CAMNULA PELLUCIDA (Scudder).

Monterey, 4,000 feet on Sounding Knob, September 1, 1 male.

This is the first record of the occurrence of this common northern species south of northern Pennsylvania. The specimen was taken close to an open oak grove at the edge of a closely grazed sheep pasture.²

PARDALOPHORA APICULATA (Harris).³

Charlottesville, March 23 (nymph), April 12 to April 19 (male adults and nymphs), April 22 to May 1 (male and female adults and nymphs), May 11 to June 28, July 14 to November 26 (nymphs), 1914, February 22 to April 8 (nymphs), November 25 (nymph), 1915.

Rock Fish Gap (Afton), May 30.

Woodstock, June 10; Fishersville, June 12.

Bells Valley, April 15, 1 male.

Monterey, August 17 (1 nymph).

Not infrequent at Charlottesville in old pastures and woodland clearings overrun with *Andropogon* and the other dry herbage. It will doubtless prove to be of frequent occurrence in similar situations throughout the mountain and valley sections, but so far the data from these sections are incomplete.

PARDALOPHORA PHOENICOPTERA (Burmeister).

Tappahannock, June 4 to August 2 (adults), October 24 (nymphs); Dunnsville, April 24 (nymphs), Mount Landing, April 28 (nymphs); Lloyds, April 28 (nymphs); Sharps, May 15 (nymph), June 22.

Charlottesville, December 5, 1913 (nymphs), March 23 to May 18 (nymphs), May 25 to June 2 (male adults, nymphs), June 4 to July 21, October 21 to October 31 (nymphs), 1914, February 22 to April 8 (nymphs), 1915.

Jarman Gap, July 30, August 1, 1 male, 1 female.

Occasional to frequent, but more or less sporadic, in *Andropogon* and other coarse grasses in old fields, pastures, and woodland clearings.

¹ Publ. No. 18, Carnegie Institution of Washington, 1904, p. 34.

² Specific determination confirmed by Mr. Rehn.

³ = *Hippiscus tuberculatus* of most authors (see Rehn and Hebard, Proc. Acad. Nat. Sci., Phila., vol. 62, 1910, p. 630, footnote). Both this and the next species have usually been included in the genus *Hippiscus*.

The eggs of this species hatch in early autumn; the young survive the winter and attain maturity late in the spring. Adults disappear by the end of July or the beginning of August.

HIPPISCUS RUGOSUS (Scudder).

Norfolk, September 17, 1914, July 11 (nymphs), 1915; Deanes, September 26; Franklin, September 18; Tappahannock, July 18 (male adults and nymphs), July 25–October 9; Center Cross, August 18; Urbanna, August 18; Sharps, June 22, (nymphs); Ottoman, August 8, September 27; Irvington, September 26.

Charlottesville, June 13 to July 3 (nymphs), July 8–17 (male adults, nymphs), July 20–31 (male and female adults and nymphs), August 11 to October 16, 1914, October 31, 1915.

Jarman Gap, July 30, 1 male.

Bolar, September 3, 1 female; Hot Springs, September 6–7.

Common, at least locally, in dry, open, untilled grass lands, especially those dominated by *Andropogon* and other coarse grasses, but not infrequent in such succulent grasses as timothy. Not observed in the higher Appalachian districts of Highland County, but rather frequent in a weedy field at Hot Springs. Its center of distribution appears to include the Coastal Plain and Piedmont region, but it spreads from there far up into the nearby mountain areas.

SPHARAGEMON BOLLI (Scudder.)

Portsmouth, October 3; Churchland, August 8–9; Deanes, September 26; Virginia Beach, September 20; Franklin, September 18; Tappahannock, July 1 (nymphs), July 23 to September 22; Irvington, September 26, 1 male.

Charlottesville, May 25 to June 20 (nymphs), June 28 (2 males, 1 female, nymphs), July 3 to October 10, 1914. •

Jarman Gap, July 30, August 1.

Monterey, August 17–31; Hot Springs, September 5–6.

Usually common in suitable stations in the mountains; apparently less frequent or more sporadic in the Piedmont and Coastal Plain sections. Occurs normally in areas of coarse grass or scrub in or about wooded tracts.

SPHARAGEMON SAXATILE PLANUM Morse.

Jarman Gap, August 1.

Monterey, August 17–22.

Appears to be fairly common in suitable stations in the mountainous sections. At Jarman Gap it occurred in considerable numbers in a closely grazed grassy pasture on the summit of the ridge, while at Monterey it was common on the higher and steeper slopes, on cleared but untilled rocky ground close to the margin of the woods, frequenting bare, thinly grassed (*Danthonia*), or briery areas. In all places it was associated with the preceding species.¹

¹ Mr. Rahn kindly verified my determination of this form.

SPHARAGEMON COLLARE WYOMINGIANUM (Thomas).

Tappahannock, July 23, 1 female (wheat stubble field), July 25, 1 male.

Small area of coarse sand bordering woods, vegetation open and scanty, consisting of short, coarse grasses and other dry herbage.

Apparently very rare in tidewater Virginia.

DISSOSTEIRA CAROLINA (Linnaeus).

Portsmouth, October 3; Churchland, August 8–9, September 15 to October 7; November 4, 1914, July 11, 1915; Deanes, September 26, Franklin, September 18, November 5; Tappahannock, November 9–12, 1914, June 1 (nymphs), June 24 to October 24, 1915; Naylor, September 17; Sharps, October 13; Ottoman, August 8, September 27.

Fredericksburg, September 5; Bells Cross Roads, October 26; Republican Grove, November 2; Charlottesville, June 13–15 (nymphs), June 17–25 (male adults, nymphs), June 26 to July 3 (male and female adults, nymphs), July 4 to October 31, 1914, October 27 to November 26, 1915.

Jarman Gap, July 30, August 1.

Monterey, August 16–31; Meadowdale, August 19; Trimble, August 15; Bolar, August 15; Hot Springs, September 5–7.

Common throughout, possibly rather more abundant in the mountain sections than in the Coastal Plain and Piedmont. Frequents bare or nearly bare areas of compact earth, occurring on highways, well-trodden paths, cultivated fields, and less frequently in dry grasslands; avoids to some extent areas of coarse or loose sand, apparently preferring silty, loamy, or clayey soils.

PSINIDIA FENESTRALIS (Serville).

Churchland, August 8, 1 male; Virginia Beach, August 9, September 20; Cape Henry, September 27; Tappahannock, July 25 to October 11; Naylor, September 17; Sharps, June 22 (nymphs), October 13; Millenbeck, August 8.

Of regular occurrence on sand dunes of ocean beaches and the sandy beaches of tidal estuaries, usually associated in such situations with the sand bur, *Cenchrus*; occasionally found a short distance inland in sandy fields or on barren areas of coarse sand.

TRIMEROTROPIS CITRINA Scudder.

Churchland, August 8, September 15 to October 1, November 4–5, 1914, July 11 (male), 1915; Deanes, September 26; Gilmerton, October 1; Deep Creek, October 1; Franklin, September 18, November 5; Tappahannock, August 25 (1 male); Wares' wharf, October 3 (1 female); Sharps, November 14, 1914 (1 male, 1 female); Millenbeck, August 8 (1 male, 1 female), September 27 (1 male).

In the Rappahannock River section all specimens were found on the sandy beaches of broad, tidal estuaries, where this species is usually associated with *Psividia*, and, like the latter, in areas characterized by the presence of sand bur, *Cenchrus*. In southeastern Virginia it appeared to be of frequent, though somewhat local, occurrence inland, inhabiting there open sandy fields and footpaths. Appears to avoid locations where there is any considerable cover of vegetation.

TRIMEROTROPIS MARITIMA (Harris).

Virginia Beach, August 9 (adults, nymphs), September 20; Cape Henry, September 20, 27; Naylor's, September 17, 1 male; Whitestone, September 26, 1 male, 1 female.

Frequent on sand dunes of sea beaches, commonly associated with *Ammophila arenaria*; occasionally occurring on sandy shores of tidal estuaries. At Naylor's the single specimen taken occurred in an area supporting *Cenchrus*.

Subfamily ACRIDIINAE.

LEPTYSTMA MARGINICOLLIS (Serville).

Portsmouth, October 3; Churchland, November 4 (1 female); Deep Creek, October 1; Cape Henry, September 20, 27 (13 adults, 1 nymph); Tappahannock, April 24 (1 female in *Andropogon*), 25 (1 male in *Andropogon*), July 18 (1 male), August 2 (juv.), 12 (juv.), 13 (male adult, nymphs), 18–October 11; Naylor's, September 17; Sharps, October 13; Millenbeck, September 27; Irvington, September 26.

Common locally in tidal marshes, where it occurs most frequently in the areas of *Scirpus americanus*, largely avoiding the true salt marsh grass, *Spartina glabra*; not uncommon in grassy or cattail bogs inland at the head of tidal streams or in the grassy thickets bordering sluggish streams (Deep Creek) not far from the coast. Occasionally spreading from the marshes to dry upland fields, where examples have been taken in *Andropogon*. So far the species has been observed in the latter only in spring and late fall. It is evident from the records given that the adults or nymphs survive the winter.

SCHISTOCERCA SERIALIS (Thunberg). [*S. americana* of authors].

Portsmouth, October 3; Churchland, August 8–9 (adults, nymphs), September 15 (adults and nymphs), 16 to October 1, November 4, 1914, July 11 (1 male), 1915; Deanes, September 26 (adults, nymphs); Gilmerton, October 1, November 6; Deep Creek, October 1; Cape Henry, September 20; Franklin, September 18, November 5; Tappahannock, April 20–29, June 7 to July 1, July 23 (nymphs), August 21 (adults, nymphs), September 9 to October 11; Naylor's, September 17; Ottoman, September 27.

Fredericksburg, September 5; Bells Cross Roads, October 26 (1 male); Republican Grove, November 2; Charlottesville, April 19 to June 15, June 16 to August 12 (adults, nymphs),¹ September 10 to October 31, 1914, October 31, 1915.

Dale Enterprise, June 11 (1 female).

Common in Coastal Plain localities and quite frequent, at least locally, in the Piedmont. Widely distributed in open country, but shows a marked preference for areas covered with tall herbage (wheat fields, timothy pastures, taller clumps of *Andropogon*, roadside thickets, etc.).

SCHISTOCERCA DAMNIFICA (Saunders).

Portsmouth, October 3; Churchland, September 16, November 4, 1914, April 17, 1915; Deanes, September 26; Gilmerton, October 1, November 6; Virginia Beach, September 20; Franklin, September 18, November 5; Tappahannock, April 24 to July 18, September 9 (adults, nymphs), September 19 to October 24; Mount Landing, April 28; Lloyds, April 28; Sharps, May 18; Ottoman, September 27; Irvington, September 26.

Charlottesville, April 2 to June 20, September 10–October 10, 1914; April 4–8, October 31, 1915.

Frequent in Coastal Plain and Piedmont region, occurring chiefly in *Andropogon* and coarse herbage generally, usually in or near wooded areas.

SCHISTOCERCA ALUTACEA (Harris) (Typical race).²

Portsmouth, October 3; Deanes, September 26; Naylor's, September 17.

Only a few examples taken, apparently quite scarce. Mostly found in bushy thickets (*Baccharis halimifolia*, *Ira oraria*) and tall grasses in low grounds bordering tidal marshes; at Deanes' taken in bracken (*Pteridium aquilinum*) scrub in low woods.

SCHISTOCERCA ALUTACEA (rubiginosa phase).

Churchland, September 23 (1 female); Tappahannock, July 25 (1 male), August 21 (1 female).

Charlottesville, July 11 (1 male), July 14 (2 males) August 11 (1 male). Hot Springs, September 5 (1 male).

Apparently quite scarce and local. Most examples were taken in areas of bunch grass (*Audropogon*) or in associated thickets. At Hot

¹ Nymphs taken July 3 were reared to adults in confinement.

² This is the phase with the continuous, median dorsal stripe. The unstriped, russet-brown form, known as *rubiginosa*, is regarded as only a color phase of *alutacea* by Rehn. On the beaches is a relatively large form closely resembling *rubiginosa*. In my article on New Jersey Orthoptera, p. 508, following a verbal suggestion by Rehn, I mentioned that the latter might be a unicolorous phase of *S. obscura*, but since the publication of that article Rehn has informed me that such is not the case. I shall accordingly refer to this form as a maritime race of *alutacea*.

Springs it occurred in scrubby undergrowth of open oak-hickory-chestnut woods of steep mountain side.

SCHISTOCERCA ALUTACEA (Maritime race).

Virginia Beach, September 20; Cape Henry, September 20.

In both localities the species was found in small numbers in wax-myrtle (*Myrica*) scrub on the sand dunes.

SCHISTOCERCA OBSCURA (Fabricius).

Churchland, September 15 (1 female), 23 (1 female), October 1 (1 female); Tappahannock, August 26 (1 female), September 6 (1 male), 13 (1 female), 26 (1 female), October 2 (1 male), 11 (1 female); Whitestone, September 26 (2 females).

This striking species appears to occur most regularly in the reedy areas of tidal marshes, having been observed on *Scirpus americanus*, *Spartina cynosuroides*, and *Typha* (cat-tails); it also occurs in the dense herbage clothing the adjoining slopes of the dry land and doubtless not infrequently wanders a considerable distance from water, specimens having been taken at Churchland in a thick growth of goose grass (*Eleusine indica*) on cultivated land and in roadside thickets.

DENDROTETTIX AUSTRALIS (Morse).¹

Monterey (Sounding Knob), September 1, 1914, 1 female, 4,000 feet.

The specimen was taken on stony ground in the shrubby undergrowth of low open woods on the mountain side.

MELANOPLUS SCUDDERI (Uhler).

Churchland, September 16, November 4; Deanes, September 26; Virginia Beach, September 20; Franklin, September 18; Tappahannock, August 21–October 24; Naylor's, September 17; Sharps, October 13; Ottoman, September 27; Irvington, September 26.

Louisa, October 26; Republican Grove, November 2; Charlottesville, December 5, 1913 (2 males, 1 female), September 10 to October 31, 1914, October 27 to November 20, 1915.

Frequent in the Piedmont and Coastal Plain localities. Occurs typically in dry, grassy tangles and undergrowth in or close to wooded areas, occasionally spreading to open, grassy and weedy fields.

MELANOPLUS CELATUS Morse.²

Jarman Gap, July 30, 1 female.

Monterey, August 20–30; Hot Springs, September 6–7.

¹ *Podisma australis* Morse. Mr. Rehn assures me that the species is actually a *Dendrotettix*, a view in which, I understand, Morse now concurs. My specimen was carefully compared with Morse's type by Mr. Hebard, who informed me there was practically no question of its being the same species.

² I am indebted to Morgan Hebard for the specific determination. He informs me the specimens are not entirely typical, the cerci being "very broad distad."

Evidently confined to the mountain sections. As noted by Morse it is a sylvan species. It appears to be very sporadic in distribution; in restricted areas it may occur in considerable numbers, as in two or three spots near Monterey, but in most places it is lacking or very scarce. All specimens were taken in or close to open, deciduous woods on mountain slopes, in grassy (*Danthonia* sp. undet.) or shrubby (ferns, oak saplings, etc.) undergrowth.

MELANOPLUS DEVIUS Morse.¹

Bolar, September 3, 1 male, 1 female.

Taken in grassy undergrowth of an open grove of sugar maple on level tract bordering a mountain stream.

MELANOPLUS GRACILIS (Bruner).²

Monterey, August 22.

Found in fair numbers in an open marsh overgrown with rank herbage (iron-weed, *Eupatorium purpureum*, sneezeweed (*Helenium*, species ?), monkshood (*Aconitum*), sedges (*Carex*), painted cup, etc.) on the outer edge of the timothy meadows bordering the stream draining the intermontane valley.

MELANOPLUS WALSHII Scudder.³

Monterey, August 23, 1 male; Hot Springs, September 6.

Frequent locally at Hot Springs in the grassy and shrubby undergrowth (blueberries, bracken, etc.) of dry, open deciduous woods on higher slopes of mountain ridges. Apparently rare in similar situations at Monterey.

MELANOPLUS ATLANTIS (Riley).

Churchland, August 8–9, September 15–October 6, November 4–6, 1914, May 31 (male and female adults, nymphs), July 11, 1915; Deanes, September 26; Gilmerton, October 1, November 6; Deep Creek, October 1; Franklin, September 18, November 5; Tappahannock, November 12, 1914, June 1 to October 24, 1915; Wares Wharf, October 3; Sharps, November 13, 1914, June 22, October 13, 1915; Urbanna, August 18; Ottoman, September 27; Irvington, September 26.

Fredericksburg, September 3; Warrenton, June 8; Bells Cross Roads, October 26; Republican Grove, November 2; Charlottesville, December 5, 1913 (5 males, 3 females), June 2–November 26, 1914, October 27–November 25, 1915.

Jarman Gap, July 30, August 1.

Front Royal, June 9; Woodstock, June 10; Fishersville, June 12.

Monterey, August 18, 1 male; Hot Springs, September 6, 1 male.

¹ Determination by Morgan Hebard.

² Determination confirmed by Rehn and Hebard.

³ = *M. emplectens* Scudder = *M. blatchleyi* Scudder.

Abundant, the dominant grasshopper east of the mountains, but apparently quite scarce in the higher Appalachians. Occurs nearly everywhere in open country, but shows a strong tendency to congregate in farm lands on sandy soils, where it frequently swarms in the grassy fields, fence borders, old stubble fields, timothy and clover pastures, and areas of crab and Bermuda grasses. In the *Andropogon* areas of old neglected fields and pastures it also occurs, but usually in much smaller numbers than in the tenderer grasses of the cultivated districts.

Observations at Charlottesville and Tappahannock indicate the occurrence of two breeds of this species during a single season. From the spring brood of nymphs, adults appear about June 1 and continue in large number until the middle or end of July, when a decided decline in numbers takes place. About the middle of August an increase is noticeable. That a new generation is maturing at this time is indicated by the finding of soft bodied adults which had evidently just completed the final molt. These adults continue to increase and in early autumn they are even more abundant than in early summer. Mating was observed as late as early October. It is doubtless this second brood of adults that lays the eggs tiding the species over winter.

MELANOPLUS FEMUR-RUBRUM (De Geer).

Norfolk, September 17; Portsmouth, October 3; Churchland, September 15, November 4; Deanes, September 26; Gilmerton, October 1; Deep Creek, October 1; Virginia Beach, September 20; Cape Henry, September 20, 27; Franklin, September 18, November 5; Tappahannock, August 21 to October 11; Wares Wharf, October 3; Naylor's, September 17; Sharps, October 13; Millenbeck, September 27; Ottoman, September 27.

Fredericksburg, September 5; Louisa, October 26; Charlottesville, December 5, 1913 (1 male, 5 females), September 10 to October 31, 1914, October 31 to November 25, 1915.

Monterey, August 16 to September 1; Meadowdale, August 19; Trimble, August 15, September 2; Bolar, August 15, September 3; Hot Springs, September 5-7.

The dominant grasshopper of the Appalachian province, abounding everywhere in the timothy and bluegrass pastures of the intermontane valleys and on the open, grassy slopes of the mountains, less frequent in open woodland or clearings. In the Piedmont region and Coastal Plain this species is much less conspicuous than *atlantis* and is largely limited to more humid situations, such as marsh borders, drainage ditches, gulleys, open "branches," and other places where the vegetation is of a moisture-loving type. It is evidently more exacting than *atlantis* in its moisture requirements.

MELANOPLUS CONFUSUS (Scudder) [= *M. minor* of authors].

Tappahannock, May 25 (1 female), June 8 (2 males 1 female) (rare or very local).

Charlottesville, May 18–23 (male), May 25 to July 21 (abundant, somewhat local).

Rock Fish Gap (Afton), May 30, (abundant), Jarman Gap, August 1 (abundant).

Monterey, August 17, 31 (occasional).

At Charlottesville this was the dominant grasshopper during late May and early June, although rather strictly limited to the higher, drier areas and not occurring in any considerable numbers on farm lands. Its choice appears to be for old upland fields and pastures overrun with coarse grasses (*Andropogon*, *Danthonia*, etc.).

MELANOPLUS LURIDUS (Dodge).

Charlottesville, June 20 to July 14 (nymphs probably this species), September 15 to October 10, 1914, October 31, 1915 (local, apparently not common).

Jarman Gap, July 30, August 1, (local, moderately frequent).

Monterey, August 17 to September 1; Hot Springs, September 5–6.

The stronghold of this species appears to be in the Appalachian region, where it was found in abundance along the margins of the woods and in clearings on the mountain slopes. It is a typical sylvan species, frequenting the grassy and shrubby undergrowth of dry woodlands.

MELANOPLUS KEELERI (Thomas).

Portsmouth, October 3; Deanes, September 26; Gilmerton, October 1, November 1; Deep Creek, October 1; Virginia Beach, September 20; Cape Henry, September 20, 27; Tappahannock, September 9 (2 males), 19 (3 males); Irvington, September 26, (1 male).

This is probably a geographic race of the preceding species. It appears to be rather sporadic in its distribution; usually it is scarce or, at most, moderately frequent, but at Virginia Beach and Cape Henry it was found to be fairly common. In its habitat preferences it resembles *luridus*, occurring typically in the grasses and low shrubbery of dry, open woodland.

MELANOPLUS BIVITTATUS (Say).

Jarman Gap, July 30, (1 male).

This specimen had the bright yellow tibiae of the typical form.

MELANOPLUS BIVITTATUS FEMORATUS (Burmeister).

Tappahannock, June 7 (juv.), 17–September 12, Newtown, August 17 (1 female); Irvington, September 26 (1 female).

Charlottesville, June 13 to July 31.

Jarman Gap, August 1.

Monterey, August 22.

Locally frequent, especially in low, moist places overgrown with dense grassy tangles and other herbage; less frequent in timothy pastures and in mixed thickets of brambles and *Andrepogon*. The species is best represented in midsummer and becomes scarce toward fall, when usually only females are encountered.

PAROXYA CLAVULIGER (Serville).¹

Portsmouth, October 3; Churchland, August 8-9, November 4; Deanes, September 26; Gilmerton, October 1; Cape Henry, September 20; Franklin, September 18, November 5; Tappahannock, July 18 to October 24; Naylor, September 17; Sharps, October 13; Ottoman, August 8; Irvington, September 26.

Charlottesville, July 11 (adults and nymphs), July 28, August 11. Jarman Gap, August 1, (3 males, 1 female, 1 nymph).

Abundant in the tidal marshes of the Coastal Plain, frequenting the dense growths of *Scirpus americanus* and *Spartina cynosuroides*, but not present in true salt marsh dominated by *Spartina glabra*. It also occurs inland in bogs and wet meadows overgrown with cat-tails, dense grasses, and other rank herbage. At Jarman Gap in the Blue Ridge the species was found in a small boggy spot near the head of a stream quite close to the summit.

Family TETTIGONIIDAE.

SCUDDERIA TEXENSIS Saussure and Pictet.

Portsmouth, October 3; Churchland, September 15; Tappahannock, July 25 to October 11; Sharps, October 3.

Charlottesville, July 17.

Bolar, September 3.

Not very evenly distributed; frequent in some places, scarce in others. Prefers areas of tall grasses (*Andropogon*) and bushes in open fields, pastures, and meadows; also noticed on tall reeds (*Spartina cynosuroides*) in tidal marshes.

SCUDDERIA PISTILLATA Brunner.

Monterey, August 22 (1 male, 1 female); Bolar, September 3 (1 male).²

At Monterey the species was found in briars and low shrubbery on dry, stony mountain slopes close to the woods covering the summit, where it was associated with *S. furcata*; at Bolar in the tall herbage of an old meadow in the intermontane valley. This is, I believe, the most southern authentic record of this species.

¹ = *P. floridiana* (Thomas) of authors, which Rehn and Hebard inform me is a synonym of *clavuliger*.

² Determination confirmed by Rehn and Hebard, who examined my specimens.

SCUDDERIA CURVICAUDA (De Geer).

Tappahannock, July 9 (1 male).

Charlottesville, July 13–14 (1 male, 1 female).

The few examples taken were obtained in bushes and briery thickets in the vicinity of woodland.

SCUDDERIA FURCATA Brunner.

Churchland, September 15; Deanes, September 26; Gilmerton, October 1; Deep Creek, October 1; Virginia Beach, September 20; Franklin, September 18; Tappahannock, September 9 to October 24; Sharps, October 13; Irvington, September 26.

Charlottesville, October 10, 1914; October 31, 1915.

Jarman Gap, July 30 (nymph).

Monterey, August 20–31; Hot Springs, September 6.

The most abundant representative of the genus, common and evenly distributed throughout, but largely restricted to sylvan stations, occurring in trees, bushes, and tall grasses in or close to woodland.

SCUDDERIA CUNEATA Morse.

Norfolk region, exact locality not specified, September 18 to October 1 (2 males); Tappahannock, August 9 (1 male).

At Tappahannock the single male taken was found in an *Andropogon* thicket close to the margin of the woods. It was associated with numerous examples of *furcata*.

AMBYCORYPHA OBLONGIFOLIA (De Geer).

Tappahannock, July 9 (1 male).

Charlottesville, July 10–27.

Moderately frequent in thickets and shrubbery, usually in the neighborhood of woodland.

AMBYCORYPHA FLORIDANA CARINATA Rehn and Hebard.

Churchland, September 23 (1 female); Gilmerton, October 1 (1 female).

Tappahannock, July 9 to August 13 (7 males, 2 females).

Charlottesville, July 11 (1 male), July 17 (1 male).

Inhabits similar situations as the last species. More frequent than *oblongifolia* in tidewater Virginia.

AMBYCORYPHA UHLERI S&L.

Churchland, October 8 (1 female); Franklin, September 18 (1 female); Tappahannock, July 31 to October 2, common in late summer, scarce in fall; Ottoman, September 27.

Charlottesville, August 11, 1914 (1 male), September 3, 1915 (2 males, species frequent).

Occurs chiefly in open country, frequenting the trees, bushes, weeds, and tall grasses of fields, pastures, and roadsides. Apparently the most abundant representative of the genus in the Piedmont and tidewater sections.

AMBYCORYPHA ROTUNDIFOLIA (Scudder).

Jarman Gap, July 30, August 1 (1 male, 1 female).

Monterey, August 16-22 (2 males, 2 females); Bolar, September 3 (1 female).

Taken in shrubbery and undergrowth in or close to open deciduous woods. Apparently confined to the mountain sections of the State.

MICROCENTRUM LAURIFOLIUM (Linnaeus).

Whitestone, September 26 (1 male); Tappahannock, September 12 (1 male).

MICROCENTRUM RETINERVE (Burmeister).

Charlottesville, October 31, 1915 (1 adult).

NEOCONOCEPHALUS EXILISCANORUS (Davis).

Tappahannock, August 9 to September 10 (12 males).

Frequent for a short period in tidal marshes (not salt), occurring most commonly in tall reeds, *Spartina cynosuroides*, but spreading in small numbers to the adjoining dry land (briery thickets, corn fields).

NEOCONOCEPHALUS LYRISTES (Rehn and Hebard).

Tappahannock, August 12 to September 13 (9 males, 1 female).

Occasional in tidal marshes; taken most frequently on *Spartina cynosuroides*, less frequently on *Scirpus americanus*. Closely resembles the preceding species, but is distinctly slenderer and has an entirely different song.

NEOCONOCEPHALUS MELANORHINUS (Rehn and Hebard).

Churchland, August 8-9 (2 males).

The writer unfortunately failed to note the exact spot at which his specimens were taken, but it was doubtless in a salt marsh bordering a narrow tidal stream. According to Rehn and Hebard the species is confined to true salt marsh (*Spartina glabra* formation).

NEOCONOCEPHALUS ENSIGER (Harris).

Monterey, August 16 (6 males).

This northern species was found frequenting the taller grasses along a narrow ditch in a timothy pasture at the foot of a mountain ridge.

¹ In this genus the specific terms are used in the sense employed in Blatchley's Orthoptera of Indiana.

² The genus *Conocephalus* of most writers.

NEOCONOCEPHALUS ROBUSTUS (Scudder).¹

Tappahannock, July 27 to September 6 (6 males, species common); Sharps, June 22 (1 juv.); Millenbeck, August 8 (1 male, 1 female, 1 juv.).

Charlottesville, June 28 to July 8 (nymphs), July 16 to August 12 (frequent); Crozet, August 1 (song heard).

Frequent on dry land or at the borders of tidal marshes, occurring on tall grasses and herbage in fields, pastures, and roadsides.

NEOCONOCEPHALUS ROBUSTUS CREPITANS (Scudder).

Tappahannock, July 23, 27 (3 males).

Associated with the preceding in similar habitats.

NEOCONOCEPHALUS PALUSTRIS (Hatchley).

Tappahannock, August 12 to October 2 (4 males, 11 females); Naylor, September 17 (1 female).

Common in tidal marsh on *Spartina cynosuroides*, less frequent on *Scirpus americanus*; also occurs on cattails and in moist depressions filled with succulent grasses at the head of gulleys.

NEOCONOCEPHALUS RETUSUS (Scudder).²

Churchland, September 15, November 4; Portsmouth, October 3; Deanes, September 26; Franklin, September 18; Tappahannock, August 21 (juv.), August 23 to October 2; Sharps, October 13.

Louisa, October 26; Charlottesville, September 10–13, 1914, September 3, 1915.

Usually frequent to common in the thick grasses of fields, pastures, meadows, and roadsides; occasional in or along the borders of tidal and other marshes.

NEOCONOCEPHALUS TRIOPS (Linnaeus).

Tappahannock, April 24, September 6 to October 2; Naylor, September 17; Sharps, May 4–8.

Charlottesville, May 11, 1914 (1 male).

Not uncommon in the dense stands of *Spartina cynosuroides* in tidal marshes, spreading to the surrounding thickets (*Baccharis*, *Myrica*, etc.), and in the spring also to the dry land, being found at that season in full song in trees, grasses, and shrubbery, as well as in the marshes.

HOMOROCORYPHUS MALIVOLANS (Scudder).

Tappahannock, July 13 to August 18, 1915 (29 males, 12 females).

Frequent, locally at least, in dense stands of *Spartina cynosuroides*

¹ Practically all the material included under this species appears to be intermediate between the typical race and the subspecies *crepitans*.

² In the writer's article on New Jersey Orthoptera, p. 522, the records there included under *triops* actually pertain to *retusus*. Rehn and Hebard by their recent revision have rendered a great service to field workers in clearing up the confusion in which this and several other related genera had previously been involved (Trans. Amer. Entom. Soc., vol. 40, 1915, pp. 365–413).

in tidal marshes; rarely occurring in briery thickets on nearby knolls. Observed ovipositing in *Spartina cynosuroides*. This, I understand, is the most northern record of the species.

ORCHELIMUM¹ AGILE (De Geer).

Norfolk, September 17; Portsmouth, October 3; Churchland, September 15-16; Gilmerton, October 1; Deep Creek, October 1; Cape Henry, September 20; Franklin, November 5; Tappahannock, August 10-October 9; Naylor's, September 17; Sharps, October 13; Millenbeck, September 27; Irvington, September 26; Whitestone, September 26.

Fredericksburg, September 5 (1 male in *Andropogon* of upland field); Charlottesville, October 31, 1915 (1 male, wet, grassy spot at head of rivulet in open field).

Usually abundant in wet or moist areas generally, especially in the *Scirpus americanus* formation of tidal marshes and the marginal fringe of succulent grasses, but never occurring in true salt marsh (*Spartina glabra*); also common in cattail, sedgey and grassy bogs inland at the head of sluggish streams. Occasionally it spreads to the adjoining dry land, specimens having been taken in goose grass (*Eleusine indica*), crab grass, foxtail grass, and *Andropogon*. The species will doubtless be found to be better represented in the Piedmont section than the present records indicate.

ORCHELIMUM GLABERRIMUM (Burmeister).²

Portsmouth, October 3; Churchland, September 15; Deanes, September 26; Gilmerton, October 1, November 6; Deep Creek, October 1; Cape Henry, September 20; Franklin, September 18, November 5.

Although I found this species quite frequent in suitable localities in southeastern Virginia, I could find no trace of it in the Rappahannock River section of tidewater Virginia. This seems strange in view of its occurrence in southern New Jersey.

In New Jersey *glaberrimum* appears to be restricted to the inland bogs (cedar swamps) of the Pine Barrens, but in the Norfolk region it is evidently more flexible in its habitat requirements. At Cape Henry, in addition to being common in the rank vegetation of dune hollows and ditches, it was not infrequent in the tall bunch grasses (*Andropogon*, *Panicum amarum*, etc.) on the surrounding dry sand dunes. Farther inland it appeared to prefer areas of stiff, but not always moist, soil, occurring in the rank plant growth of ditches and woodland borders and scrub. It evidently has a strong predilection for sylvan surroundings.

¹ The nomenclature here adopted in this and the following genus is that used by Rehn and Hebard in their recent revision (See Trans. Amer. Entom. Soc., vol. 41, 1915, pp. 11-83 and 155-224.)

² This name, used by most writers in the past for the long-winged phase of *vulgare*, actually belongs, according to Rehn and Hebard, to the *O. erythrocephalum* of Davis, which therefore becomes a synonym. It was under the latter term that I included all my personal records of the present species in my list of New Jersey Orthoptera, the term *glaberrimum* there being mistakenly applied to a form which has since been described by Rehn and Hebard as a distinct species under the name *superbum*.

ORCHELIMUM VULGARE Harris.

Churchland, September 15 to October 4, November 4; Deanes, September 26; Gilmerton, October 1; Deep Creek, October 1; Cape Henry, September 20; Franklin, September 18, November 5; Tappahannock, August 16–October 11; Wares Wharf, October 3; Naylor's, September 17; Sharps, October 13; Ottoman, August 8, September 27; Irvington, September 26.

Fredericksburg, September 5; Charlottesville, October 16, 1914.

Monterey, August 17–30; Hot Springs, September 6.

Common at all the localities listed, except Charlottesville, where only a relatively small number have so far been observed.

This is the least specialized representative of the genus in its habitat selections. It frequents tall grasses, weeds, and bushes on dry land, or land that may be damp or temporarily wet, but largely avoids areas of standing water or saturated soil such as are found in stagnant bogs and tidal marshes, being replaced in such places in the Coastal Plain by *agile*. In the mountain section, however, it was common in wet meadows, but these are occupied by a more varied herbaceous vegetation than that of the bogs and tidal marshes of the Coastal Plain. Typically *vulgare* occurs in open situations, but in certain sections of tidewater Virginia (Irvington, Ottoman) I found it common on *Andropogon* in woodland clearings, and in the mountains in the dry, scrubby undergrowth of wooded slopes.

ORCHELIMUM LATICAUDA Redtenbacher.

Tappahannock, August 13 to October 2 (19 males, 3 females); Wares Wharf, October 3 (2 males); Sharps, October 13 (1 male); Ottoman, August 8 (1 male).

Occasional in a variety of situations, occurring regularly in tidal and fresh-water marshes and pond borders, but the males, at least, spreading in small numbers to upland districts where the species was taken in a field of dense millet and in a thick growth of ragweed bordering the fence of a town lot. In the tidal marshes it was found in *Spartina cynosuroides* and in the marginal fringe of switch grasses. In fresh water bogs it was taken on various grasses, cattails, sedges, and bushes (e. g. *alder*). Unlike most members of the genus it appears to have a strong preference for woodland habitats.

ORCHELIMUM MINOR Bruner.

Tappahannock, September 19–October 11, (11 males); Sharps, October 13, (Note); Millenbeck (note), September 27; Irvington, September 26 (1 female).

Occasional in pine trees (*P. taeda*, *virginiana*, *echinata*); the single female was captured in the blueberry undergrowth of pine woods.

ORCHELIMUM CONCINNUM Scudder.¹

Portsmouth, October 3; Churchland, August 8-9, November 4; Cape Henry, September 20; Tappahannock, July 24 to September 7; Naylor, September 17; Sharps, October 13.

Abundant in the *Scirpus americanus* formations of tidal marshes, less common in the associated *Spartina cynosuroides* and occasionally found in *Spartina glabra* (Sharps), but not typical of the latter, which it almost entirely avoids. At Tappahannock this species, although abundant in early and middle August, became quite scarce by early September, at which time it had been replaced as the dominant form of the tidal marshes by *agile*; on the other hand, it was found in abundance on the opposite side of the Rappahannock at Naylor as late as September 17, but at this place *agile* was relatively scarce. Can it be that these two species are competitors and that *agile* after its advent gradually eliminates its rival?

ORCHELIMUM FIDICINUM Rehn and Hobard.

Portsmouth, October 3 (1 female); Millenbeck, August 8, September 27; Whitestone, September 26.

Locally abundant in salt marshes, a characteristic denizen of the true salt marsh grass, *Spartina glabra*. At Whitestone this species was very abundant.

ORCHELIMUM SUPERBUM Rehn and Hobard.

Tappahannock, July 27-28, 1915 (4 males).

This recently described species was found on *Scirpus americanus* in tidal marshes. Two of the specimens differ from the type in having the outer genicular lobes of the caudal femora bispinose instead of unispinose.

CONOCEPHALUS : FASCIATUS (De Geer).

Churchland, August 8-9, September 15-16, November 4, 1914, July 11, 1915; Norfolk, July 11; Deep Creek, October 1; Deanes, September 26; Franklin, September 18, November 5; Tappahannock, June 17 to October 24; Naylor, September 17; Sharps, June 22, October 13; Ottoman, August 8, September 27; Millenbeck, September 27; Irvington, September 26.

Fredericksburg, September 5; Charlottesville, June 15 to September 10.

Jarman Gap, August 1.

Monterey, August 16-31; Meadowdale, August 19; Trimble, August 15; Bolar, August 15.

A highly adaptable species, occurring abundantly in a variety of habitats in the Coastal Plain; more local and largely restricted to

¹ Called *O. herbaceum* in my List of New Jersey Orthoptera, p. 527.

² - Genus *Xiphiidum* of most authors.

humid areas in the Piedmont and Appalachian sections, though still quite common, but in the latter surpassed by *C. brevipennis*. Occurs in open grassy fields and pastures, frequenting more especially the tenderer vegetation of farm lands (e. g., timothy, red-top, goose grass, Bermuda grass, clover) and moist or wet places generally, including tidal marshes (*Scirpus americanus*, *Distichlis spicata*), but not true salt marsh. Largely avoids wooded locations. May be two-brooded in Virginia.

CONOCEPHALUS BREVIPENNIS (Scudder).

Norfolk, September 17; Portsmouth, October 3; Churchland, September 15-16, November 4; Deanes, September 26; Gilmerton, October 1; Deep Creek, October 1; Virginia Beach, September 20; Franklin, September 18, November, 5; Tappahannock, August 18 to September 22; Naylor's, September 17.

Charlottesville, August 11, 1914 (1 male, 1 female).

Monterey, August 16-31; Meadowdale, August 19; Trimble, August 15, September 3; Bolar, August 15; Hot Springs, September 5-6.

Abundant throughout in the Appalachian localities, frequenting the pastures and meadows of the intermontane valleys and spreading into the open deciduous woods of the mountain summits, where it was not infrequent in the relatively dry grassy or shrubby undergrowth; its preference, however, is for moist or somewhat humid locations. In the Piedmont section and Coastal Plain this species appears to be scarce or at most only locally frequent, being confined largely to low humid areas (marshes, "branches," ditches, drains, springheads, etc.) or the denser undergrowth of woods. It evidently never occurs in tidal marshes. In the Rappahannock River section it appeared to be quite exceptional, but was of more regular and frequent occurrence in the region around Norfolk.

CONOCEPHALUS NEMORALIS (Scudder).

Charlottesville, October 10, 1914 (1 female), October 31, 1915 (2 males, Carter Mountain).

The exact distribution of this species in the region east of the Central States is still uncertain. All the available records are from localities along the front of the Appalachians. Besides the locality here given, the species is also known in Virginia from Luray, but I do not know of any records from the mountain section, despite the rather careful search I made for it while in that section.

CONOCEPHALUS STRICTUS (Scudder).

Norfolk, September 17; Portsmouth, October 3; Churchland, August 8 (juv.), September 15; Deanes, September 26; Gilmerton, October 1; Deep Creek, October 1; Cape Henry, September 20; Franklin, September 18; Tappahannock, August 13-October 2; Wares Wharf, October 3.

Fredericksburg, September 5; Louisa, October 26 (1 male); Charlottesville, September 10–October 31, 1914.

Monterey, August 22 (adults, nymphs), August 31; Bolar, September 3; Hot Springs, September 7.

Occasional or moderately frequent in open, undisturbed, dry grasslands, especially partial to *Andropogon*, but taken also in *Danthonia*.

CONOCEPHALUS STICTOMERUS Rehn and Hebard.

Churchland, August 8 (1 female),¹ September 15 (1 female); Tappahannock, July 31–October 2 (18 males, 9 females, 4 juv.).

Occasional in tidal marshes, especially in the tall reeds, *Spartina cynosuroides*, upon the spikelets of which it was observed feeding; less frequent in *Scirpus americanus*. Apparently active only at night.

CONOCEPHALUS NIGROPLEUROIDES (Fox).

Churchland, September 15 to October 1.

Occasional in tall *Spartina glabra* fringing small tidal creek. Not observed in the salt marshes of the lower Rappahannock River.

CONOCEPHALUS SPARTINAE (Fox).

Portsmouth, October 3; Churchland, September 15 to October 1, 1914; July 11, 1915 (1 female); Tappahannock, July 18 to September 7; Wares Wharf, October 3; Sharps, October 13; Millenbeck, August 8, September 27; Whitestone, September 26.

Usually common in true salt marshes, frequenting *Spartina glabra* and occasional in tidal marshes beyond the influence of salt water (Tappahannock), occurring in the latter on *Scirpus americanus* and *Spartina cynosuroides*.

CONOCEPHALUS SALTANS (Scudder).

Portsmouth, October 3; Churchland, September 16; Deanes, September 26; Gilmerton, November 6; Franklin, September 18; Tappahannock, August 21 (juv.), September 9 to October 11; Dunnsville, October 3.

Charlottesville, September 10 to October 31, 1914.

Occasional to frequent in coarse, dry grasses (*Andropogon*) usually in the vicinity of wooded areas.

ATLANTICUS TESTACEUS (Scudder).²

Charlottesville, March 27–May 25 (nymphs), June 23 to July 16, 1914.

Occasional in dry, open woodland or wooded borders, frequenting low shrubbery.

¹ This specimen is atypical, having the ovipositor considerably longer than in typical examples. See measurements in the recent revision of the genus by Rehn and Hebard.

² = *A. pachymerus* of authors. Mr. Rehn kindly determined all my examples of this genus collected in 1914.

ATLANTICUS AMERICANUS (Saussure).¹

Virginia Beach, September 20 (1 male); Franklin, September 18 (1 female); Tappahannock, September 22 (1 male, 1 female), October 11 (1 female).

Found in *Andropogon* scrub at margin of woods and in the undergrowth of pine woods.

ATLANTICUS DAVISI Rehn and Hebard.

Monterey, August 20 (1 female), September 1 (1 female); Hot Springs, September 6 (1 male).

Taken in grassy and shubby undergrowth of dry mountain woods.

CAMPTONOTUS CAROLINENSIS (Gerstaecker).

Tappahannock, July 28 (1 male).

Family GRYLLIDAE.**GRYLLUS ASSIMILIS Fabricius.**

Norfolk, September 17; Churchland, September 15 to October 4, November 4-6; Gilmerton, October 1; Franklin, September 18; Tappahannock, April 24 to October 24.

Charlottesville, July 8 (1 female).

Hot Springs, September 6 (1 female).

Common in grassy tangles and underbrush of all kinds in fields, pastures, and borders of marshes.

ANUROGRYLLUS MUTICUS. ²

Tappahannock, June 7 to July 25.

Charlottesville, May 26 to June 3.

Frequent in fields and pastures and along fence rows. Nocturnal in habits, singing at or close to the mouth of its burrow.

MIOGRYLLUS VERTICALIS (Serville). ³

Tappahannock, June 28 to July 18 (2 males, 1 female).

Taken in short, bright green, tender grass growing on damp ground of sun-lit path in low woods.

NEMOBIUS FASCIATUS (De Geer).

Norfolk, September 17; Franklin, September 18; Tappahannock, August 21 to October 9.

Charlottesville, June 27-July 31 (nymphs).

Jarman Gap, July 30 (nymphs).

Monterey, August 16 to September 1; Meadowdale, August 19; Bolar, September 3; Hot Springs, September 6-7.

Abundant in grassy tangles and sod land generally, especially in damp spots. Ubiquitous in the mountainous section, more local or sporadic in the Piedmont region and Coastal Plain.

¹ = *A. dorsalis* of authors.

² Mr. Hebard kindly examined my 1914 specimens and referred them to this species with query.

³ Determined by Mr. Hebard. = *M. saussurei* of authors.

NEMOBIUS MACULATUS Blatchley. ¹

Tappahannock, September 22 (1 female in tender grass of damp spot on path in deciduous woods).

NEMOBIUS CUBENSIS Saunders.

Tappahannock, September 6 (1 female on road through tidal marsh close to dense formation of *Spartina cynosuroides*).

OECANTHUS NIGRICORNIS Walker.

Monterey, August 17 to September 1 (1 adult).

OECANTHUS LATIPENNIS Riley.

Tappahannock, November 12, 1914 (1 female); August 12 (2 juv.), 21 to September 9, 1915 (4 females). (Old stubble field, roadside thickets.)

Hot Springs, September 6 (three adults, dry open woods of mountain summit).

OECANTHUS ANGUSTIPENNIS Fitch.

Charlottesville, July 14-17 (on oak in open grove).

OECANTHUS QUADRIPUNCTATUS Bent.

Deep Creek, October 1 (1 female); Virginia Beach, September 20 (1 female); Cape Henry, September 20; Tappahannock, July 9 to September 19.

Charlottesville, June 16 (nymphs), July 3-14 (adults, nymphs).

Common on weeds and shrubbery in fields, open woodland and borders of marshes.

ANAXIPHA EXIGUA (Say).

Tappahannock, September 9 (1 female on *Scirpus americanus* in tidal marsh).

Charlottesville, July 14 (1 juv.).

APITHES AGITATOR Uhler.

Norfolk region (exact locality not certain), September 15 to October 3 (1 male, 1 female); Tappahannock, September 9 to October 2 (2 females).

Occurs in thickets and low brush of roadsides and field borders.

OROCHARIS SALTATOR Uhler.

Franklin, September 18 (1 female, undergrowth of pine woods).

¹ Determinations in this genus by Mr. Hebard.

FOSSIL FISHES IN THE COLLECTION OF THE UNITED STATES NATIONAL MUSEUM.

BY CHARLES R. EASTMAN.

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INTRODUCTION.

The collection of fossil fishes belonging to the United States National Museum, although not extensive, is a representative series, comprising characteristic species from all of the main geological time divisions from the Ordovician onward, and including about 170 type-specimens and other important material which has served in the description of species or determination of geological horizons. The greater part of the material was obtained under the auspices of the United States geological surveys and exploring expeditions, and a large quantity of fish remains was added to the collection through the acquisition of a number of important private collections, like those of Lesquereux, Lacoe, Sherwood, and others. Some foreign material, from various horizons, but chiefly Mesozoic and Tertiary, was acquired at different times by exchange or purchase.

Prior to the installation of the collection of fossil vertebrates in the new building of the United States National Museum the fishes had not been systematically studied, nor even fully accessible nor arranged, owing to lack of space accommodations; and until eight years ago no published list had been prepared of the important type-specimens it contains. In 1905, under the direction of Dr. George P. Merrill, a catalogue of the type specimens of fossil invertebrates, by Charles Schuchert and associates, was published by the museum, and two years later this was followed by a second part, including the type specimens of fossil vertebrates and fossil plants.¹ The second part of this Catalogue records a wealth of material upon which Leidy, Cope, and Marsh founded much of their early work in vertebrate paleontology.

¹ Catalogue of the type and figured specimens of Fossils, Minerals, Rocks and Ores, etc. Part 2. Fossil Vertebrates, Fossil Plants, etc. Bull. U. S. Nat. Mus., No. 53, pt. 2, 1907.

During the first half of the year 1914, in pursuance of arrangements made by Dr. Charles D. Walcott, the fossil fish remains in the United States National Museum were systematically arranged and put in order by the present writer, and a number of undescribed or scientifically interesting specimens were set aside for special study. The greater part of these were afterwards placed in the hands of Mr. R. Weber for the purpose of preparing suitable illustrations to accompany a report upon the collection, which is now printed in the following pages. To Dr. G. P. Merrill, head curator of geology, and to Mr. J. W. Gidley and Mr. C. W. Gilmore, of the Section of Vertebrate Paleontology, cordial thanks are returned for the enjoyment of many privileges and courtesies extended while the work of studying the collection was in progress.

A. ORDOVICIAN SYSTEM.

The earliest remains of vertebrate life anywhere found are those occurring at several Ordovician localities in Colorado, the Bighorn Mountains of Montana, and the Black Hills uplift of South Dakota. The longest and best known of these localities is Harding Quarry, a short distance west of Canon City, Colorado, where vast quantities of detached scales and other fragmentary hard parts of primitive fishes are contained in sandstone (now known as the Harding sandstone) usually correlated with the Lower Trenton of the eastern United States and Lower Bala of Wales. R. S. Bassler in his bibliographic index of American Ordovician and Silurian fossils places the Harding sandstone in the Black River groups because it underlies the Kinnsnick limestone of uppermost Black River age.

Three species, supposed to represent true fishes, were established by Dr. C. D. Walcott,¹ after an examination of hundreds of fragments collected by himself and Dr. T. W. Stanton at Canon City in 1890 and 1891, and the ichthyic nature of the remains was confirmed by Dr. Otto Jaekel's study of microscopic sections of dermal plates belonging to two of the species.

Cope, however, in a review of Walcott's paper, expressed the opinion that it is "extremely unlikely that these forms are fishes, but they are more likely *Agnatha*." Under this latter term the author just quoted included the great extinct group of fishlike vertebrates to which he applied the name of Ostracodermi, and to which he assigned a lower rank than that of Pisces proper.

¹ Walcott, C. D. Notes on the discovery of a vertebrate fauna in Silurian (Ordovician) strata. Bull. Geol. Soc. Amer., vol. 3, 1892, pp. 153-172. Doctor Jaekel's views as to the nature of the remains are appended to this article, and are again stated in a review published by him in Neues Jahrb. f. Mineral., 1895, p. 162. Cope's review is found in the American Naturalist for March 1893, pp. 268-269. See also the same journal for February, 1891, p. 137, for a notice of Doctor Walcott's first communication.

Influenced by the idea that some of the tuberculated dermal plates described by Doctor Walcott from the Canon City locality bore a strong resemblance to certain well-known Devonian fishes, such as *Coccosteus* and *Asterolepids*, the suggestion has been put forward by some writers that the fish beds at Canon City are probably not of Ordovician but of Devonian age. The suggestion appears untenable in view of the fact that the accompanying invertebrate fauna, represented by more than thirty species, exhibits clearly the facies of the Middle Ordovician limestone of New York and the Mississippi Valley. The same invertebrate fauna persists upward to a horizon 180 feet above the fish beds, and includes a number of highly characteristic forms, such as *Receptaculites oweni* and various molluscos and crustacean species. An excellent account of this and the corresponding section in Wyoming was published by N. H. Darton ¹ in 1907, and two years later the same author ² announced the discovery of fish remains in the Ordovician near Rapid City, South Dakota.

Still more recently, in 1913, the discovery was announced by T. D. A. Cockerell ³ of another locality in Colorado, near Ohio City, at which fish-remains occur similar to those found at Canon City, and accompanied by the same invertebrate fauna. Professor Cockerell is impressed by the extraordinary resemblance that the fish remains from the Ohio City locality bear to well-known types of Devonian fishes, and claims to have found representatives of three families, *Diplacanthidae*, *Holoptychiidae*, and *Coccosteidae*. These determinations are admitted, however, to be merely approximate, and can only be accepted in a provisional sense until the material has been carefully investigated. The Ordovician age of the containing beds seems to be conclusively established by the evidence of invertebrate remains.

OSTRACODERMI.

ASTRASPIDAE, new family.

An imperfectly definable family, known only by a single genus, *Astraspis*, which has the large median dorsal and ventral plates of the body armor constructed in the same fashion as in the *Psammosteidae*, out of fused polygonal tesserae, and the external ornament of these plates also similar in a general way to that observed in various genera of *Heterostracous Ostracoderms*.

¹ Ordovician of the Bighorn Mountains. Bull. Geol. Soc. Amer., vol. 17, 1907, pp. 541-566.

² Discovery of fish remains in the Ordovician of the Black Hills, South Dakota. Bull. Geol. Soc. Amer., vol. 19, 1909, pp. 567-568.

³ Cockerell, T. D. A. Ordovician (?) fish remains in Colorado. Amer. Naturalist, vol. 47, 1913, pp. 246-247.

Genus *ASTRASPIS* Walcott.*ASTRASPIS DESIDERATA* Walcott.

Plate 12, figs. 5, 6.

Astraspis desiderata WALCOTT, Bull. Geol. Soc. Amer., vol. 3, 1892, p. 166, pl. 3, figs. 6-14; pl. 4, figs. 1-4.

The original specimens upon which this species was founded are preserved in the United States National Museum collection, and are catalogued under the number 2351. They consist of fragmentary plates, ornamented with a coarse tuberculation, and not sufficiently complete to permit of even ordinal determination. A suggestion was made, however, by the original author that the form was allied to Devonian Antiarchs like *Asterolepis ornata*.

Some months after the presentation of Doctor Walcott's paper before the Geological Society in 1891, and before it had been printed in the bulletin, a unique and extremely important specimen of *Astraspis* was discovered at the type locality, and a brief description of it was given by Doctor Walcott in a footnote dated March, 1892, added to page 167 of his paper. This specimen is now preserved in the Museum collection (Cat. No. 8121) and is illustrated for the first time in the accompanying plate 12, figure 6. Preserved in the form of an impression of the outer surface, a plaster cast taken from the natural mold is shown in figure 5 of the same plate.

The later discovered specimen shows a structural characteristic which the earlier known fragments failed to disclose, namely, that the large element, or shield, is of compound nature, being made up of a large number of small polygonal tesserae in precisely the same manner as in Cephalaspids and Psammosteids. Moreover, the style of ornamentation is similar to that observed in the families just named, each of the small polygonal tesserae rising into a conspicuous central prominence which is surrounded by numerous minute stellate tubercles. The compound nature of the shield was recognized by Walcott, and the tuberculated ornament was compared by him with the somewhat similar features displayed in *Thyestes verrucosus* Eichwald, in which the larger tubercles are disposed in several longitudinal rows. Influenced by this consideration, and also by a resemblance in general outline, Walcott reached the conclusion that *Astraspis* was related on the one hand to "cephalaspidian fishes of the Silurian of Russia," and on the other to "Asterolepidae of the lower Devonian."¹

The large compound plate of *Astraspis* was homologized by Walcott with the head-shield of Cephalaspids, although it fails to exhibit any trace of orbits and other prominences characteristic of that group or of other members of the Aspidocephalous order of Ostracodermes. Because these features are lacking in the impression of the plate be-

¹ Bull. Geol. Soc. Amer., vol. 3, 1892, p. 167.

fore us, we should prefer to compare it with the large dorsomedian shield of *Psammosteus* and *Drepanaspis*, more particularly with such forms as *Psammosteus taylori* Traquair, from the Scottish Old Red Sandstone, and the Russian *P. paradoxus*. For an account of the structure of the shield in the two last-named species we may refer to recent papers by Traquair, Woodward, and Preobrajensky in which the organization of *Psammosteus* is described.¹

The large compound plate of *Astraspis* differs from the dorsomedian and ventromedian shields of known *Psammosteidae* not only in outline, so far as may be judged from the portion preserved, but also in the presence of a median and two lateral ridges, which extend over the anterior half of the plate in a longitudinal direction. The outermost of these folds is apparently very close to and parallel with the external margin of the plate. The ridges in question recall somewhat the rows of enlarged tubercles seen in the head-shield of *Thyestes* and *Tremataspis*. Owing to their presence, and to the peculiar form of the shield, which resembles somewhat a dorsomedian plate of *Coccosteus*, it seems necessary to place the genus *Astraspis* in an independent family, closely allied to the *Psammosteidae*. Some further remarks on the genus *Psammosteus* will be found under the caption of Silurian fishes.

Formation and locality.—Hastings sandstone, Black River group; Canon City.

B. SILURIAN SYSTEM.

Family PTERASPIDAE Smith Woodward.

Genus PALAEASPIS Clappole.

PALAEASPIS AMERICANA Clappole.

Palaeaspis americana CLAYPOLE, Amer. Naturalist, vol. 18, 1884, p. 1224.

Palaeaspis bitruncata CLAYPOLE, Amer. Naturalist, vol. 18, 1884, p. 1224.

Palaeaspis elliptica CLAYPOLE, Proc. Amer. Assoc. Adv. Sci., 1885, p. 426.

This species is represented in the collection by a number of fragmentary remains, none of which adds to our knowledge of the structural organization. It deserves to be recalled, however, that the reported presence of paired appendages in this species has been disproved by Dr. Bashford Dean, his investigation of the type material having shown that the structures regarded as such by the original describer are in reality Elasmobranch spines resembling *Onchus*, which have become accidentally associated with the dermal shields of *Palaeaspis*. The dorsal shield consists apparently of a single plate,

¹ Traquair, R. H. Additional notes on the fossil fishes of the Upper Old Red Sandstone of the Moray Firth Area. Proc. Roy. Phys. Soc. Edinb., vol. 13, 1897, p. 379. Woodward, A. S. On the Upper Devonian Ostracoderm, *Psammosteus taylori*. Ann. Mag. Nat. Hist., ser. 8, vol. 8, 1911, pp. 648-652. Preobrajensky, J. A. Ueber einige Vertreter der Familie *Psammosteidae* Ag. Sitzber. Naturforsch. Gesellsch. Univ. Dorpat, vol. 19, 1910, pp. 21-36. (Text in Russian.)

and differs from that of *Pteraspis*¹ in lacking a posterior median spine. So far as at present known, the genus is monotypic, and limited to the Salina beds (Cayugan or "Neontaric") of the New York State geological survey scheme of classification. Dr. O. P. Hay is in error in citing this genus as occurring in the Onondaga stage of the Devonian.

C. DEVONIAN SYSTEM.

Family ASTEROLEPIDAE Traquair.

Genus BOTHRIOLEPIS Eichwald.

BOTHRIOLEPIS COLORADENSIS Eastman.

Bothriolepis coloradensis EASTMAN, Amer. Journ. Sci., vol. 18, 1904, p. 254, text figs. 2, 4.

The type material upon which this, the largest known American species of the genus, was founded, is now preserved in the collection of the National Museum. It was collected, together with a quantity of other Devonian fish-remains, by Dr. Whitman Cross in 1903, from the Elbert formation of Rockwood and Devon Point in southwestern Colorado. The occurrence is interesting on account of demonstrating the widespread distribution of the genus in Upper Devonian time, and also because it is difficult to trace a route of migration which would connect this species with its nearest ally in the western hemisphere, *B. canadensis* Whiteaves, from Scaumenac Bay in the Province of Quebec, Canada.

BOTHRIOLEPIS NITIDA (Leidy).

Stenacanthus nitidus LEIDY, Proc. Acad. Nat. Sci., Phila., vol. 8, 1856, p. 11, and Journal, ser. 2, vol. 3, p. 164, pl. 16, figs. 7, 8.

Holonema rugosa COPE (errore), Proc. U. S. Nat. Mus., vol. 14, 1891, p. 456, pl. 30, fig. 7.

This species, known only by fragmentary portions of the dermal armor and appendages, occurs abundantly in the Catskill sandstone along the border line between New York and Pennsylvania. Numerous specimens belonging to this form are contained in the Sherwood and Lacoe collections, now the property of the United States National Museum. One specimen in the Lacoe collection calls for special notice, for the reason that it was figured and described by Cope as a pectoral limb of the genus *Holonema*. It is from the Catskill of Mansfield, Tioga County, Pennsylvania, and bears the catalogue number 1981. H. S. Williams, in 1893, first recognized it as an appendage of *Bothriolepis*, but erroneously referred it to *B. canadensis*.

¹ Important new light on the structure of this genus is contained in a paper by F. Drevermann, Ueber *Pteraspis dunensis*, published in Zeitschr. Deutsch. Geol. Gesell., vol. 56, 1904, pp. 275-289. It is noticed by Gaskell in his Origin of the Vertebrates, London, 1908. See also the following by Johann Kjaer: A new Downtonian fauna in the sandstone series of the Kristiania area. Vid.-Selek. Skrifter, Kristiania, 1911, No. 7, pp. 5-22.

Family PSAMMOSTEIDAE Traquair.

Genus PSAMMOSTEUS Agassiz.

Syn. *Placosteus* and *Psammolepis* Agassiz; *Dyptychosteus* Preobrajensky.

This genus is represented in the United States National Museum collection by a few fragmentary remains from the Devonian of north-west Russia, received through the School of Mines at St. Petersburg. Until about a score of years ago little was known concerning the skeletal organization of the primitive chordates belonging to this and related genera, and competent authorities assigned *Psammosteus* to a position among the Elasmobranchs. In October, 1894, however, Dr. R. H. Traquair¹ published a description of a new species of *Psammosteus*, named by him *P. taylori*, from the Upper Old Red Sandstone of the Elgin district, Scotland, and in the light of his subsequent discovery of nearly complete specimens of *Drepanaspis* in the Lower Devonian of Germany, the Scottish author² suggested that *Psammosteus* should be placed in close association with *Drepanaspis* in the Heterostracous section of the Ostracodermi. Some further details concerning the body armor of *P. taylori* were made known by Dr. A. Smith Woodward³ in 1911, the result of which was to confirm Doctor Traquair's reference of the genus to the Ostracoderms.

About the time when *Psammosteus* was first discovered in Scotland, in 1895, a brief notice of the various plates and spines of the same genus which are preserved in the Museum of the University of Dorpat was published by Dr. A. S. Woodward,⁴ who had examined the remains three years previously, and in this article a figure was given of a dorsomedian shield of *P. paradoxus* Agassiz, from the Upper Devonian of Neuhausen, Livonia. A copy of Woodward's illustration of this plate is shown in the accompanying text-figure 1; and the reason for our noticing it thus particularly is because the identical specimen was again figured in 1910, by a Russian geologist who had evidently overlooked the earlier writings of Traquair and Smith Woodward, and proposed to establish a new genus and species upon the evidence of the plate in question.

In this paper by Doctor Preobrajensky,⁵ the text of which is in Russian, the question of nomenclature is still further complicated by

¹ Ann. Scott. Nat. Hist., vol. 3, 1894, p. 225; also The Extinct Vertebrata of the Moray Firth Area, in Brown and Buckley's Vert. Fauna Moray Basin, 1896, pp. 260-263.

² Traquair, R. H. Report on fossil fishes . . . from the Silurian rocks of the South of Scotland. Trans. Roy. Soc. Edinb., vol. 39, 1899, p. 648.

³ Woodward, A. S. On the Upper Devonian Ostracoderm, *Psammosteus taylori*. Ann. Mag. Nat. Hist., ser. 8, vol. 8, 1911, pp. 648-652.

⁴ Woodward, A. S. The problem of the primeval Sharks. Natural Sci., vol. 6, 1896, pp. 38-43, fig. 1.

⁵ Preobrajensky, J. A. Ueber einige Vertreter der Familie der Psammosteidae Ag. Sitzber. Naturforsch. Gesell. Univ. Dorpat, vol. 19, 1910, pp. 21-36, pl. 2.

the fact that the type-species of the supposed new genus "*Dyptychosteus*" is named *tesselatus*, a title under which another species of *Psammosteus* had been previously described by Traquair.¹ If at some

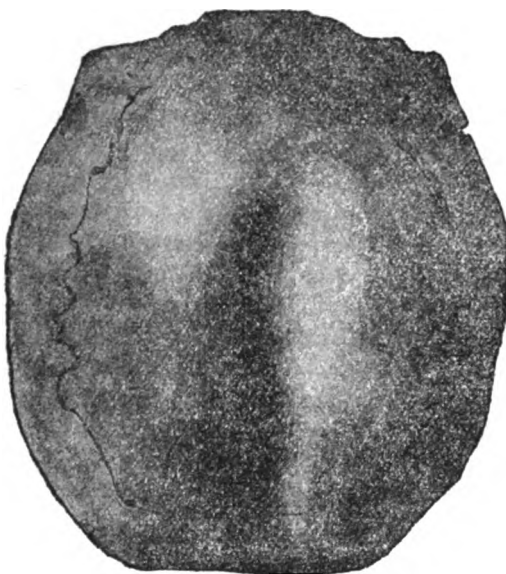


FIG. 1.—DORSOMEDIAN SHIELD OF *PSAMMOSTEUS PARADOXUS* AGASSIZ, WANTING SUPERFICIAL ORNAMENTATION. UPPER DEVONIAN, NEUHAUSEN, LIVONIA. (AFTER A. S. WOODWARD AND PREOBRAJENSKY.)

future time the Dorpat plate should be proved to be distinct from *Psammosteus paradoxus*, a new specific designation must be applied to it. For the present, however, we prefer to regard the term "*Dyptychosteus tessellatus*" as a synonym of *P. paradoxus*. Also, as far as one may judge from the published figure of the plate called by the Dorpat author *Psammosteus imperfectus*, this would appear to be one of the dorsomedian plates of *Ceraspis carinata* Schlüter.

The type material upon which the last-named species was founded is now

preserved in the Museum of Comparative Zoology at Cambridge, Mass. A side view of one of the dorsomedian plates of this form is shown in plate 11, figure 1.

HOLOCEPHALI.

Family PTYCTODONTIDAE Smith Woodward.

The typical genus of this family, *Ptyctodus*, which is at the same time the most abundant and widely distributed of any belonging in the same association, was established by Pander in 1858, upon the evidence of detached "teeth," or tritors as they are more properly called, found in the Middle Devonian of the Governments of St. Petersburg, Novgorod, and the Russian Baltic Sea provinces. In the National Museum collection are contained a number of interesting fish-remains from these localities in northwestern Russia, and also from the vicinity of Dorpat. These consist of *Ptyctodus* tritors (from Babino, Novgorod), *Dendrodus*, *Holoptychinus*, *Psammosteus*, and

¹ Proc. Roy. Phys. Soc. Edinb., vol. 13, 1867, p. 377, pl. 11, figs. 1, 2.

for the most part fragmentary and dissociated plates of Asterolepids. The records show that a small but characteristic assortment of Russian Devonian fishes was received in exchange from the School of Mines at St. Petersburg many years ago. Some well-preserved Ptyctodont dental plates from the Upper Devonian of Iowa (State quarry beds) are also contained in the collection.

The Ptyctodont type of dentition agrees so closely with that of modern Chimaeroids that the opinion has been generally held, until recently at least, the forms of Devonian fishes possessing these characteristic dental plates must have been similar in their organization to modern Holocephali, and should be provisionally included in the same subclass. The view as to the relationships of Ptyctodontidae which has commonly prevailed up until about the year 1906 is well stated by Dean in his monograph on Chimaeroids, published by the Carnegie Institution of Washington.¹

The passage reads:

The main virtue in the study of Ptyctodontids is to the writer this, that they present some evidence (1) that Chimaeroids are of Devonian stock; (2) that at this early period their dental plates were still but four in number, representing the dental structure of the jaw-halves of sharks; and (3) that the tritons existed as small points forming together a texture in the dental plates which is well known among early sharks.

In the same year (July, 1906) a totally different conception of Ptyctodont relationships was advanced by Dr. Otto Jaekel, of Greifswald, who declared his belief that Ptyctodonts belong to the Chondrosteian division of ganoid fishes, and that sturgeons themselves are related to "Placoderms" (*i. e.*, Arthrodires *plus* Asterolepids). The reasons for advocating this novel view are not stated by the author, except that they resulted from his investigation of newly discovered Rhynchodont remains from the Upper Devonian of Wildungen, described by him under the preoccupied title of *Rhamphodus*.²

In the course of his investigation of the Wildungen fish-remains certain dermal plates having a characteristic form and tuberculated ornament were found, the like of which occur also in the Middle Devonian of Wisconsin, and recall the dermal ossifications of *Myriacanthus*. Jaekel, however, in his discussion of the Wildungen material published in July, 1906,³ interprets these scale-like dermal structures as the elements of a primary, internally situated pectoral arch, and attempts a hypothetical reconstruction of the arch after the pattern

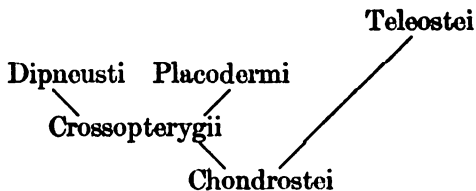
¹ Publication No. 32, 1906, p. 136.

² This generic name, with the type species of *Rhamphodus dispar*, was proposed by J. W. Davis in 1883 for certain Coeliodont teeth from the Lower Carboniferous limestone of Armagh. The dental plates upon which the so-called "*Rhamphodus tetradon*" of Jaekel was founded are identical with the earlier described plates from the Eifel Devonian, known as *Rhynchodus major* Eastman. See Amer. Naturalist, vol. 32, 1898, p. 487; vol. 38, 1904, p. 296.

³ Einige Beiträge zur Morphologie der ältesten Wirbeltiere. Sitzber. Ges. Naturforsch. Freunde Berlin, 1906, No. 7, pp. 180-189.

of the shoulder girdle in modern sturgeons. Impressed with the similarity which he observes between this conjectural arrangement and that presented by the body armoring of Arthroires, he draws the inference that the latter group belong to the same stock as sturgeons. Apparently this view, together with the acceptance of Jaekel's reconstruction of a "shoulder-girdle" in Rhynchodus, influenced Dollo¹ to declare in favor of associating Ptyctodonts with Arthroires.

It need only be said in this connection that the presence of an ossified pectoral arch in any genus of Ptyctodonts is an unconfirmed speculation very difficult to maintain in the lack of positive evidence; and the elements which have been interpreted as constituting it in a single genus are clearly of very different nature, being externally situated. And in case of any near affinity between Ptyctodonts and Arthroires, we should expect the dental plates of the former to be accompanied by an ossified head-shield and other hard parts similar to those invariably associated with Arthroires, which is precisely what we do not find in nature. The formerly prevalent view that Ptyctodonts are of Chimaeroid stock is in harmony with all the evidence thus far obtained. It may be of interest to introduce at this point a diagrammatic scheme taken from a paper by C. Tate Regan² for the purpose of showing graphically that author's ideas of the relationships of the sturgeons and "Placoderms" (i. e., Arthroires plus Antiarcha and Osteostraci, according to Regan's definition) to the other orders of Teleostomes:



Genus **HETERACANTHUS** Newberry.

Syn. *Gamphacanthus* S. A. Miller.

This is a provisional genus, founded upon detached fin-spines occurring in the Middle Devonian of Wisconsin and adjoining states, the relationships of which are uncertain. Their association in the same beds with large dental plates of *Palaeomylus* and other Ptyctodonts affords reason for believing them to be of Chimaeroid nature, and for the present they may be tentatively referred to the family now under consideration.

¹ Dollo, L., Les Ptyctodontes sont des Arthroïdes. Bull. Soc. Belge Géol., etc., vol. 27, 1907, pp. 1-12.

² The Phylogeny of the Teleostomi. Ann. Mag. Nat. Hist., ser. 7, vol. 13, 1904, pp. 329-349.

HETERACANTHUS UDDENI Lindahl.

Plate 1.

Heteracanthus uddeni LINDAHL, Journ. Cincinnati Soc. Nat. Hist., vol. 19, 1895 p. 95, pl. 6.

The spines of this species are less abundant than those of the coeval *H. politus*, which have a different general outline and a relatively coarse ornamentation. The type-specimen serving for the establishment of this species, now preserved in the Museum of the Cincinnati Society of Natural History, has the external surface partly denuded and is defective in preservation as regards the basal portion and anterior margin. Up to the present time, however, it has remained the most complete fin-spine of the species and genus thus far brought to light. During the past year a larger and still more perfect specimen has been found in the Cedar Valley limestone near Iowa City, Iowa, by Prof. Abram O. Thomas, of the State University, and placed in the writer's hands for study. It is shown of the natural size in plate 1.

The posterior or convex margin of the newly discovered spine is more strongly arched than in the type-specimen, and the distal portion is forwardly curved to a slight degree. On the other hand the anterior margin is not developed so strongly as to form a projecting shoulder toward the base, which is the case to a certain extent in the type-specimen, and in which respect an approach is indicated to the conditions observed in *Stethacanthus* and Lower Carboniferous species of *Oracanthus*. Nevertheless, the character of the ornamentation is practically identical with that of the original upon which the species is founded, and for that reason we are disinclined to regard the two spines as specifically distinct. In the specimen here figured, the entire outline of the inserted portion of the base is distinctly shown, and the resemblance of the inserted part to the base of Chimaeroid head-spines, and also those of Carboniferous forms like *Physonemus*, etc., is obvious. It is probable that the dermal defenses of this nature occupied a position immediately behind the head.

Formation and locality.—Cedar Valley limestone (Middle Devonian); Johnson county, Iowa.

DIPNOI.

Family CTENODONTIDAE Traquair.

Genus DIPTERUS Sedgwick and Murchison.

The earliest known occurrence of Dipterine remains in this country is that of a dental plate of *Dipterus* itself which has been described within the last few years from the Columbus limestone (Middle

Devonian) of Ohio.¹ Some half-dozen species, all of them founded on isolated teeth, are known from the Chemung-Catskill of New York and Pennsylvania, and great numbers are found in the Middle and Upper Devonian of Iowa. Although fish remains were reported from the Ouray limestone in the San Juan region of Colorado as long ago as 1874, and several species were brought to light by Dr. Whitman Cross in 1904, from the immediately underlying Elbert formation in the same region, no Dipterine remains were collected from the Colorado Devonian until the year 1909, when detached dental plates referable to three species already known from the Iowa Devonian were obtained by Doctor Cross. These specimens are now preserved in the Museum collection, and may be identified as belonging to *Dipterus mordax*, *D. pectinatus*, and *D. digitatus*. A single smooth crushing plate suggestive of the *Synthetodus* type of dentition is also contained in the collection made at the new locality, which is in the Elbert formation of Florida Valley, east side, in the Ignacio Quadrangle of southwestern Colorado.

A more particular account of these remains has recently been published (1915) in the *Annals of the Carnegie Museum*.² It may be here stated, without entering into details, that the evidence furnished by the three above-named species of *Dipterus*, and one undescribed *Synthetodus*-like plate, is sufficient for establishing a close correlation between the Elbert formation of Colorado and the Upper Devonian of the Cedar Valley region of Iowa. According to this correlation a somewhat later age must be assigned to the Ouray limestone than has hitherto been conceded.³ The recent discovery of Dipterine remains in the San Juan country also simplifies the problem of distribution of this class of fishes in the Devonian. For we now find evidence that the line of communication between the Appalachian and Cordilleran regions during late Devonian times was actually by way of the Ohioan and Dakotan seas; and also that intermigration took place between the faunas of the Elbert formation and the so-called State Quarry beds of Iowa toward the close of the Devonian. This statement finds further confirmation in a discovery made by Dr. E. Kirk during the past year (1914) of a well-preserved *Dipterus* dental plate from the type section of the Jefferson limestone on Galatin River, near Logan, Montana. The specimen has been recently added to the Museum collection. In plate 7, fig. 6, is shown a Coccoostean ventro-lateral plate from the Elbert formation of the San Juan region, collected by Doctor Cross. Although clearly of arthrodiran

¹ Stauffer, C. S. The Middle Devonian of Ohio. Bull. Geol. Surv. Ohio, 1909, No. 10, p. 196.

² Eastman, C. R. *Dipterus* remains from the Upper Devonian of Colorado. Annals Carnegie Mus., vol. 9, 1915, No. 3, pp. 279-283.

³ Hay, O. P. Description of a new species of *Cladodus* (*C. formosus*) from the Devonian of Colorado. Amer. Geologist, vol. 30, 1903, pp. 373-374. Girty, G. H. Devonian fossils from Colorado. The fauna of the Ouray limestone. 20th Ann. Rept. U. S. Geol. Surv., 1900, pt. 2, pp. 25-81. The Devonian fauna of the Ouray limestones. Bull. U. S. Geol. Surv., 1909, No. 391, 36 p., 10 pls.

nature, it is not capable of precise systematic determination. The text-figure 2, copied from a recent paper by Dr. W. K. Gregory, permits of a comparison of the cranial pattern of *Dipterus* and *Scaumenacia*. In still later studies by D. M. S. Watson and Henry Day (1916), slightly different homologies are recognized than those here indicated.

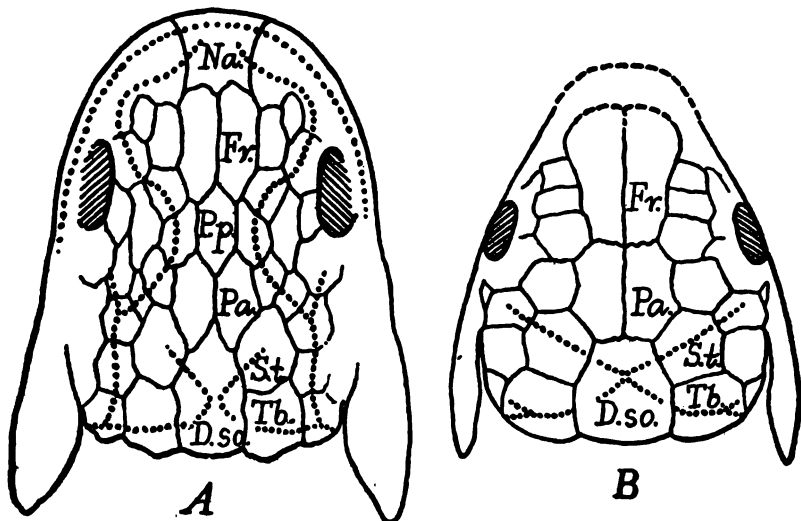


FIG. 2.—PATTERN OF SKULL-TOP OF DEVONIAN DIPNOANS. A, *DIPTERUS VALENCIENNESI*, AFTER GOODRICH, SLIGHTLY MODIFIED BY W. K. GREGORY. B, *SCAUMENACIA CURTA*, AFTER HUSSAKOF. IN SPECIMENS OF *DIPTERUS* THE NUMEROUS SENSORY PITS ARE SCATTERED OVER BROAD TRACTS, THE GENERAL DIRECTIONS OF WHICH ARE INDICATED BY THE DOTTED LINES, EXCEPT IN THE OCCIPITAL REGION WHERE THE DOTTED LINES REPRESENT SHALLOW GROOVES. THE "PARIETALS," "FRONTALS," ETC., ARE PROBABLY NOT HOMOGENEOUS WITH THOSE OF TETRAPODA. Dso, DERMOSUPRAOCCIPITAL; Fr, FRONTALS; Na, NASORTHOMOID REGION; St, SUPRATEMPORAL (PTEROTIC); Tb, TABULAR (EPITIC); Parietal, PREPARIETAL.

DIPTERUS ANGUSTUS (Newberry).

Plate 8, fig. 5.

Sagenodus angustus NEWBERRY, TRANS. N. Y. Acad. Sci., vol. 16, 1897, p. 303, pl. 24, fig. 26.

The holotype, and until recently, the solitary known example of this species, is a worn and imperfectly preserved dental plate from the Catskill of Bradford County, Pennsylvania, now the property of the American Museum of Natural History. The illustration given of it in Newberry's posthumous paper is unsatisfactory, as it would seem to represent a complete tooth, disengaged from the matrix, and with nearly smooth superficial ridges. In point of fact the tooth is embedded in a block of hard sandstone, and the external margin is partially concealed by matrix, so that the entire outline of the tooth is not visible. Moreover, although the oral surface is considerably worn, it is plain that all of the ridges were tuberculated, this condition being very distinct in the two posterior ridges. As noted by Newberry, the anterior ridge is widely divergent from the others

A second specimen (pl. 8, fig. 5), preserved in the form of an impression, and apparently referable to this species, is contained in the United States National Museum collection. It is from the Chemung of Bradford County, Pennsylvania, and agrees closely in form and size with the type of *D. angustus* except that it displays one additional ridge near the posterior extremity, and all of the radiating ridges are distinctly tuberculated. The same separation is observed between the two anterior ridges as was noted by Newberry in his description of the type. The characters of this species resemble those of *Ctenodus serratus*, from the Coal Measures of Ohio, more nearly than other described species of *Dipterus*.

Family COCCOSTEIDAE Smith Woodward.

Genus DINICHTHYS Newberry.

Among the interesting remains of this genus contained in the United States National Museum collection may be mentioned the type mandible (Cat. No. 65) upon which the species *D. newberryi* Clarke was founded, from the Genesee shale of Bristol, New York. Another figured specimen is part of the head-shield of *D. pustulosus* Eastman (Cat. No. 19) from the Hamilton limestone of Milwaukee, Wisconsin. Indications of the same species in the Upper Devonian State Quarry beds of Johnson County, Iowa, have recently been discovered by Prof. Abram O. Thomas, of Iowa State University. Particularly noteworthy among the specimens obtained by him is a portion of the dorsomedian shield showing the posterior carinal process. It is shown in plate 8, fig. 8. The corresponding element of a closely related species from the Upper Devonian of Louisiana, Missouri, has recently been described under the name of *D. missouriensis* by E. B. Branson.¹ Some fragmentary *Dinichthyid* plates from the same locality are preserved in the Museum collection.

The older restorations of *Dinichthys* and allied European coccosteian genera are well known. Within recent years several writers have proposed certain modifications of the earlier arrangements of cranial and body plates in typical genera, not all of which can be said to be entirely successful. The latest attempted reconstruction of *Dinichthys terrelli* is that of E. B. Branson, published in the *Ohio Naturalist* for June, 1908,² which drew forth some critical comment by Bashford Dean in *Science* three years later (vol. 34, p. 801). The typical species of *Coccosteus*, and also that commonly referred to "*Brachydirus*" under von Koenen's term of *B. bidorsatus*, were made the subject of new reconstructions by G.

¹ Branson, E. B. The Devonian fishes of Missouri. Bull. Univ. Missouri, vol. 15, 1914, No. 31, p. 61, pl. 2, fig. 4.

² Vol. 8, pp. 363-369.

Gürich¹ in 1891, and some further changes in the restoration of *Coccosteus* were proposed in a series of articles by Otto Jaekel,² published during the first decade of the present century. Concerning one of the restorations put forward by the last-named author, that of the cranial shield of his so-called *Pachyosteus bulla*, it is to be noted that the pattern of plate arrangement is almost precisely the same as observed in primitive species of *Dinichthys*. This will be obvious from a comparison of the annexed text-figures 3 and 4, showing respectively the Wildungen species and *D. halmodeus* from the New York Devonian.

DINICHTHYS TUBERCULATUS Newberry.

Plate 2, fig. 1.

Dinichthys tuberculatus NEWBERRY, Monogr. U. S. Geol. Surv., vol. 16, 1889, p. 98, pl. 32, fig. 3.

Of this species only isolated plates of the body armor are known, most of them imperfectly preserved. Only one, an antero-dorso-

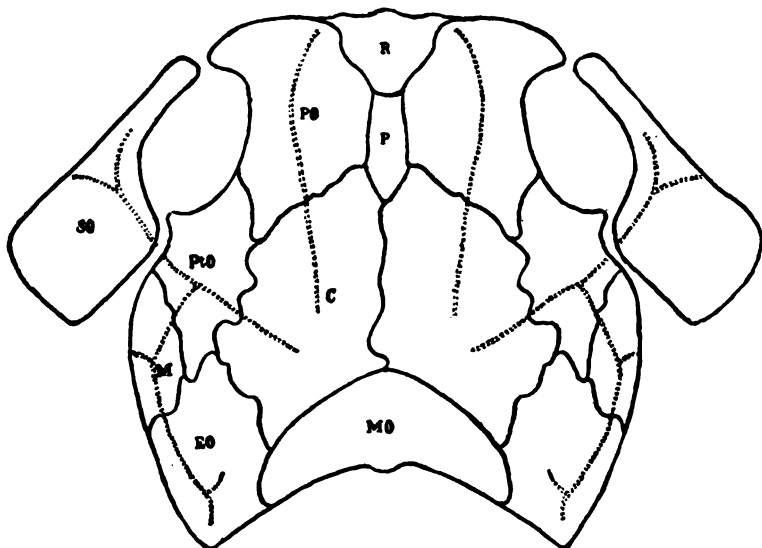


FIG. 3.—*DINICHTHYS BULLA* (JAEKEL). UPPER DEVONIAN, WILDUNGEN, GERMANY. RESTORATION OF HEAD-SHIELD, SLIGHTLY MODIFIED AFTER JAEKEL. C, CENTRAL; EO, EXTERNAL OCCIPITAL; M, MARGINAL; MO, MEDIAN OCCIPITAL; P, PINEAL; PO, PREORBITAL; P10, POSTORBITAL; R, ROSTRAL; SO, SUBORBITAL.

lateral element, from the Chemung of Warren, Pennsylvania, was figured by Newberry. Regarding this species, this author remarks:

In size this fish was comparatively small; the suprascapular plates are about three inches in length and breadth and nearly half an inch in thickness at the center. . . . The dorsomedian is also very small: it was not more than three inches in breadth and length, judging from the portion preserved.

¹ Gürich, G. Ueber Placodermen und andere devonische Fischreste in Breslauer mineralogischen Museum. Zeitschr. Deutsch. Geol. Ges., vol. 43, 1891, pp. 902-913.

² Jaekel, O. Ueber *Coccosteus* und die Beurtheilung der Placodermen Sitzber. Ges. Naturf. Freunde Berlin, 1902, No. 5, pp. 103-115; Ueber die Organisation und systematische Stellung der Asterolepiden. Zeitschr. Deutsch. Geol. Ges., vol. 55, 1903, Mai-Protokoll, pp. 41-60; Einige Beiträge zur Morphologie der ältesten Wirbeltiere. Sitzber. Ges. Naturf. Freunde Berlin, 1906 No. 7, pp. 180-189; 1907, p. 172, text fig. 1.

Among the arthrodiran plates in the United States National Museum collection from the same horizon and locality are several that may be provisionally referred to this species, but owing to failure of preservation of the superficial ornament, a positive determination of the species is impossible. There is a tolerably complete antero-

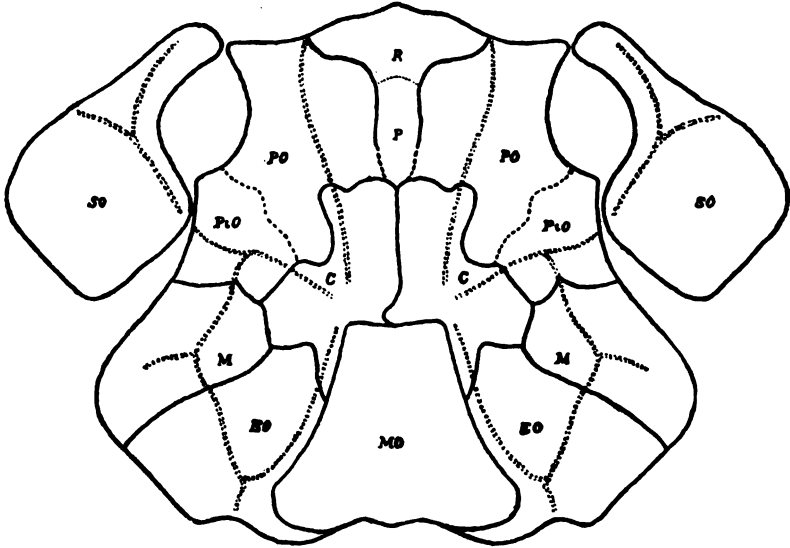


FIG. 4.—*DINICHTHYS HALMODEUS* (CLARKE). MARCELLUS SHALE (ERIAN), LIVONIA SALT SHAFT, NEW YORK. RESTORATION OF HEAD-SHIELD $\times \frac{1}{2}$. LETTERING AS IN FIG. 3.

ventro-lateral plate in the collection, of relatively small size, and also a very good example of the dorsomedian, which has not been previously figured for this species. It is shown of slightly less than the natural size in plate 2, figure 1.

Formation and locality.—Chemung group (Upper Devonian); Warren County, Pennsylvania.

Genus MYLOSTOMA Newberry.

The arrangement of the grinding elements constituting the upper dentition of the best-known species of this genus, *M. variabile*, has been the subject of much discussion during recent years, chiefly by American writers. Up to the present time no evidence has been found of the occurrence of a pair of vomerine teeth in this genus corresponding to the so-called "premaxillary" teeth (in reality vomerine) of *Dinichthys*; but that a pair of such elements was developed is rendered at least a plausible supposition from analogy with *Dinomylostoma*, from the Portage shale of western New York.

Whereas in former years the problem of orientation of palatal grinding plates depended upon more or less theoretical considerations, we are now fortunately provided with evidence of the most positive

kind for the allocation of parts entering into the upper dental pavement. The evidence referred to is furnished by a single large compound plate, representing the fused members of the anterior pair of mylostomid dental plates, found in the isolated condition, and originally described by Louis Hussakof¹ in 1909 as the type of a distinct genus and species of Arthrodires. It has been suggested by the present writer² that the new genus proposed by Doctor Hussakof, and named by him *Dinognathus*, be maintained in a provisional sense,

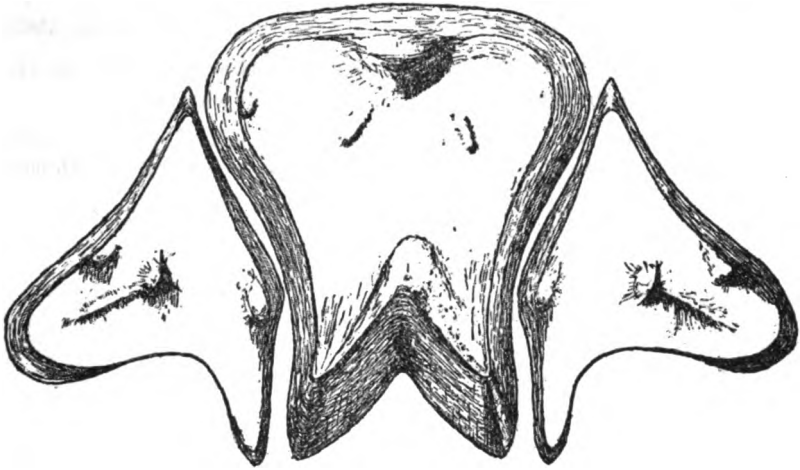


FIG. 5.—*DINOGNATHUS FEROX* (HUSSAKOF). CLEVELAND SHALE (UPPER DEVONIAN), LORAIN COUNTY, OHIO. RECONSTRUCTION OF THE UPPER DENTAL PAVEMENT.

and that there should be associated with it, on theoretical grounds, the unique mandible serving for the type of Newberry's species, *Mylostoma terrelli*.

A recent examination of the type material of both *Mylostoma* and *Dinognathus*, now preserved in the American Museum of Natural History, has satisfied the writer of the entire correctness of this view; and in text-figure 5 is illustrated our conception of the arrangement of the palatal dental elements of *Dinognathus*. It is to be noted that in this genus the anterior pair of palato-pterygoid dental plates is fused into a single crushing element. In *Dinichthys*, on the other hand, the so-called "shear-tooth" is to be interpreted as having arisen from the fusion of the anteriorly and posteriorly placed elements on either side of the upper jaw.

¹Hussakof, L. The systematic relationships of certain American Arthrodires. Bull. Amer. Mus. Nat. Hist., vol. 28, 1909, p. 268, fig. 5.

²Science, vol. 29, 1909, p. 997; Bull. Mus. Comp. Zool., 1909, vol. 52, pp. 261-269.

TELEOSTOMI.

Family RHIZODONTIDAE Traquair.

Genus SAURIPTERUS Hall.

SAURIPTERUS TAYLORI Hall.

Plate 2, fig. 2; plate 7, fig. 5.

Sauripteris taylori HALL, Nat. Hist. N. Y., pt. 4, Geology, 1843, p. 282, text-fig. 130.—NEWBERRY, Monogr. U. S. Geol. Surv., vol. 16, 1889, p. 112.—BROOM, Bull. Amer. Mus. Nat. Hist., vol. 32, 1913, pp. 459–463; Anat. Anz., vol. 45, 1913, pp. 73–78.—GREGORY, Ann. N. Y. Acad. Sci., vol. 26, 1915, pp. 358–362.

The extent of our information in regard to this genus has recently been summed up by Dr. Robert Broom, as follows:¹

Sauripterus is known only by fragments of the head, a series of crushed vertebræ, a large number of scales and the beautifully preserved right pectoral fin with most of

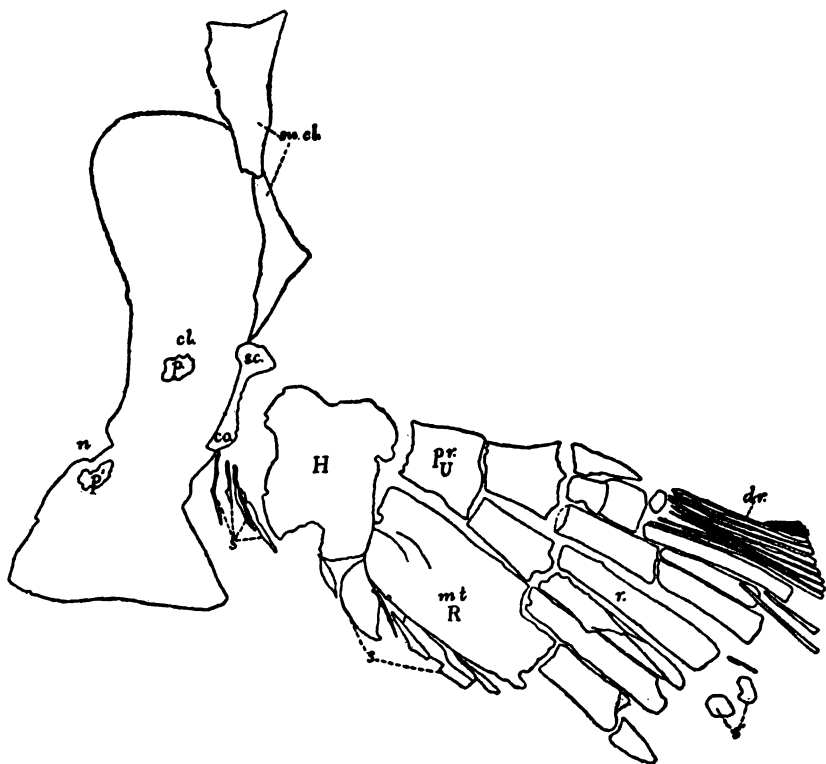


FIG. 6.—SAURIPTERUS TAYLORI HALL. CATSKILL, PENNSYLVANIA. RIGHT PECTORAL LIMB OF TYPE-SPECIMEN WITH PARTS IN THEIR NATURALLY ASSOCIATED POSITION. (AFTER W. K. GREGORY).

the cleithrum and part of the supraclavicle (text fig. 6). The large comparatively thin scales resemble those of *Rhizodopsis* and the cleithrum closely resembles that of *Rhizodus*. The vertebral centra are formed by rings of bone. Owing to the crushed condition of the vertebræ it is impossible to be quite sure whether the ring is entire or

¹ Bull. Amer. Mus. Nat. Hist., vol. 32, 1913, p. 461. See, also, on the Rhipidistia, the important article by D. M. S. Watson and Henry Day in Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 60, 1916, pt. 1, pp. 1–52.

made up of four parts. There is certainly a well-ossified neural arch and above this in some of the vertebrae at least a well-developed flattened neural spine. The teeth have the enamel deeply folded at the bases as seen in the figures given.

This passage is followed by a detailed description of the pectoral limb in the type-specimen, now preserved in the American Museum of Natural History; but there is no further discussion of the head parts. Still more recently the limb structure of the Rhipidistia, as exemplified by the same type-specimen of *Sauripterus* has been made the subject of searching investigation and comparison with other

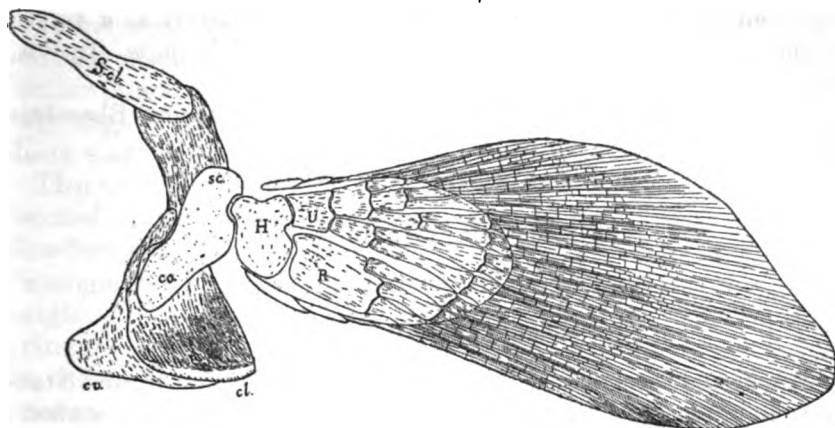


FIG. 7.—SAURIPTERUS TAYLORI HALL. CATSKILL, PENNSYLVANIA. RESTORATION OF THE RIGHT PECTORAL LIMB, SEEN FROM THE INNER SIDE. THE MESOPTERYGIAL SERIES IS REPRESENTED BY THE HUMERUS (H), ULNA (U) AND DISTALLY SUCCEEDING ELEMENTS; THE PREAXIAL RADIALS (R) ARE BARELY REPRESENTED. THE SCAPULACORACOID, CLAVICLE (cl), SUPRACLEITHRUM (s. cl.), AND FIN RAYS ARE CONJECTURALLY RESTORED FROM ANALOGY WITH RELATED GENERA. (AFTER W. K. GREGORY).

ichthyic and tetrapod appendages in a paper published during the present year by Dr. W. K. Gregory.¹

As a result of his investigations Dr. Gregory adopts the view, already advocated by Doctor Broom, that the ascending blade in the shoulder-girdle of *Sauripterus* (text fig. 6) represents the cleithrum of primitive Stegocephali; and accordingly, he is able to recognize the the following homologies of parts:

RHIPIDISTIA.

Interclavicular corium.
Clavicle ("infraclavicle").
Supracleithrum ("supraclavicle").
Post-temporal.
Coracoscapula.
Fleshy lobe of fin.
Mesopterygium (single basal piece).
Mesopterygial axis.
Preaxial parameres (radials) reduced or absent.
Postaxial parameres.
Dermal rays.

PRIMITIVE TETRAPODA.

Interclavicle.
Clavicle.
?Fused with top of cleithrum.
Lost.
Coracoscapula.
Arm and hand.
Humerus.
Humerus, ulna, ulnare, digit V (?)
Lost.
Radius, carpus, digits I-IV (?)
Lost.

¹ Ann. N. Y. Acad. Sci., vol. 26, 1915, pp. 358-362.

The only specimen showing a portion of the cranial roof that has thus far come to light is that illustrated in plate 2, fig. 2, which shows the parietals, frontals and one each of the squamosals and postfrontals in natural juxtaposition. The parietals are of about the same relative length as in *Holoptychius*, and less elongate than in *Rhizodopsis* and *Onychodus*; but further than this it is not possible to make comparisons, owing to the inadequate preservation of parts. Nevertheless, being unique, the specimen is of importance for the bare hint it affords of the arrangement of cranial roofing plates in this genus. Another fragmentary head structure, to be interpreted probably as a portion of the basisphenoid of this or some closely related form, is shown in plate 7, fig. 5.

Formation and locality.—Catskill (Upper Devonian) near Blossburg, Pennsylvania.

D. CARBONIFEROUS SYSTEM.

ELASMOBRANCHII

Family CLADODONTIDAE.

Genus CLADODUS Agassiz.

Among the specimens of fossil fishes acquired by the United States National Museum from Dr. G. Hambach, of St. Louis, is a series of well preserved teeth of Cladodont, Petalodont, and Cochliodont sharks from different horizons of the Mississippian section, and also a number of interesting ichthyodorulites, some of which add to our knowledge of established species. These are noticed in the following paragraphs under their appropriate headings.

CLADODUS SPINOSUS Newberry and Worthen.

Plate 8, fig. 7.

Cladodus spinosus NEWBERRY and WORTHEN, Pal. Illinois, vol. 2, 1866, p. 22, pl. 1, fig. 3.—E. B. BRANSON, 30th Ann. Rept, Dept. Geol. Nat. Resources Indiana, 1906, p. 1377, pl. 41, figs. 1, 2.

The large, highly ornate teeth belonging to this species are of rare occurrence in the St. Louis limestone, and few perfect specimens have been obtained. One which shows the characters of the base and lateral denticles very clearly is catalogued under the number 8104, from the Hambach collection. It is the largest of any that have come under the writer's observation, but unfortunately lacks the apical portion of the crown. From the amended definition of this species given by E. B. Branson I quote as follows:

Teeth of medium or large size, broader than high; base representing a little more than half of an imperfect hexagon, with the posterior side slightly longer than the others; thick, with a sharpish edge behind, before strong beveled, and under scooped out in a shallow sinus beneath the median cone; whole anterior border of base, above

the smooth beveled edge, set with many minute spines directed upward; these spines cover the antero-lateral edges of the base of the principal cone. Median cone conical, somewhat curved backward, rapidly tapering to an acute point; lower portion with a nearly circular section, finely and evenly striated longitudinally, near the point smooth, compressed, with cutting edges; lateral denticles 6-7 on either side, conical, striated and curved backward, exterior pair much larger than intermediate ones.

Formation and locality.—St. Louis limestone, Missouri.

CLADODUS ACULEATUS, new species.

Plate 10, fig. 4; plate 18, fig. 1.

Teeth small, the crown consisting of a long, slender, erect, and pointed median cone, with faint longitudinal striae, and a pair of similar lateral cones rising to about half the height of the principal cone, only slightly divergent, and all three with slight sigmoidal curvature. Root short, not very deep.

The teeth in this species are of relatively small size and gracefully formed. They agree more nearly in general form with *C. gracilis* Newberry and Worthen, from the Coal Measures of Indiana, but are distinguished from this and from other known species by the greater height of the lateral denticles and their closer approximation to the principal median cone, which is extremely slender from base to apex. In the specimen selected as type (Cat. No. 8106, U.S.N.M.) of the new species, the total height is only about 11 mm., and a second specimen in the same collection is still smaller.

The two known specimens which have been obtained of this species are each contained in small black concretions found in the Caney shale of Antlers Quadrangle, Oklahoma, the exact locality being that referred to as No. 3987 in Doctor Girty's paper on the Fauna of the Caney Shale of Oklahoma.¹ An extensive collection of fossiliferous nodules from this and other localities in the same region was made by Doctor Girty, and is now preserved in the United States National Museum. Comparatively few of these concretions contain fish remains, but among them are several interesting forms, such as spines of *Stethacanthus*, arthrodiran body plates, and small Palaeoniscids showing the internal structure of the head. Two *Coccosteus*-like antero-ventro-lateral plates are shown in plate 10, figures 5 and 6. These remains are noticed hereinafter.

The only mention that has previously been made of the occurrence of fish remains in the Caney shale is to be found in Doctor Girty's discussion of the fauna in Bulletin 377 of the Geological Survey. The author there remarks (p. 13):

Another neglected type is the fishes, represented not only by teeth but by what appear to be fragments of bone. In this connection may be mentioned agglomerations of organic fragments, possible of coprolitic origin, which occur as a rule in small concretions.

¹ Bull. U. S. Geol. Surv., No. 377, 1900, p. 75.

About 50 species of invertebrates are known from the Caney shale, and the beds are tentatively correlated in age with the uppermost Mississippian or base of the Pennsylvanian.

CLADODUS COMPRESSUS Branson.

For purposes of bibliographical record it may be stated here that the type-specimen upon which this species is founded was named *Cladodus striatus* in the original description.¹ It was pointed out by the present writer² that this name could not be used, Agassiz having already applied it to the type species of *Cladodus*; and in an article published in Science,³ Doctor Branson proposed that it be replaced by the title of *C. compressus*.

Genus DICRENODUS Romanovsky.

Syn. *Carcharopsis* Agassiz; *Pristicladodus* M'Coy.

This genus is represented by a single species in the Mississippian rocks of this country, described by Newberry under the name of *Carcharopsis wortheni*.⁴ A second North American species appears to be indicated by the specimen immediately to be described.

DICRENODUS TEXANUS, new species.

Plate 7, fig. 4.

Founded upon a unique tooth having a total height of 2.5 cm., and width at base of crown of 2 cm. In general form resembling the type of *D. wortheni* (Newberry), but anterior coronal face slightly concave, no lateral cusps at the base, and root with deep median sinus. Coronal margins strongly and evenly crenulated from the apex to the base, and summits of the lateral crenulations secondarily notched.

The type and solitary known specimen of the new cladodont just described is catalogued as No. 8097. It was collected by Prof. J. A. Udden, of the University of Texas, in 1914, from strata of Pennsylvanian age near San Saba, Texas, and by him presented to the Museum through the present writer. From the same horizon and locality Professor Udden also obtained the ichthyodroulites hereinafter referred to under the caption of *Physonemus gemmatus*.

Family PETALODONTIDAE Newberry and Worthen.

Of this extinct family only a single genus is known, *Janassa*, in which other skeletal parts have been found in natural association with the dentition. No fin-spines are known to occur in this genus, hence it is unlikely that such defenses were present in other members of the same family. Jaekel, however, in a valuable article on the

¹ 30th Ann. Rept. Dept. Geol. Nat. Resources Indiana, 1906, p. 1378.

² Memoir 10, N. Y. State Museum, 1907, p. 62.

³ Vol. 27, 1908, p. 311.

⁴ Pal. Illinois, vol. 2, 1866, p. 69, pl. 4, fig. 14.

structure of Petalodonts,¹ has suggested that the fin-spines known as *Stichacanthus* and *Physonemus* (including *Xystacanthus* and *Batacanthus*) should be associated on theoretical grounds with the teeth of *Polyrhizodus* and *Petalodus* respectively. He also conjectured that the teeth of *Petalodus* and *Ctenoptychius* were borne in the mouth of one and the same genus of Palaeozoic sharks.

Genus POLYRHIZODUS M'Coy.

Syn. *Dactylodus* Newberry and Worthen.

As remarked by Dr. A. S. Woodward in his Catalogue of Fossil Fishes in the British Museum (Part 1, p. 56), "no teeth of this genus having been found thus far in natural association, it is impossible to distinguish between specific characters and the variations exhibited by teeth in different parts of a single jaw." There is, however, some reason in support of Jaekel's surmise that the teeth of *Polyrhizodus* are associated in the same jaw with those having low and elongate crowns, commonly referred to *Chomatodus*.

POLYRHIZODUS CONCAVUS (St. John and Worthen).

Plate 8, fig. 4.

The teeth of this species resemble those of *P. princeps* (the type species of the so-called "*Dactylodus*"), but are smaller, and the base of the crown is more strongly arched downward in the middle. A single specimen in the Museum collection, catalogued as No. 8100, is peculiar in showing an apparently undivided root.

Formation and locality.—St. Louis limestone (Mississippian); near Alton, Illinois (from the Hambach collection).

POLYRHIZODUS GRANDIS, new species.

Plate 8, figs. 1, 2.

Teeth robust and of relatively large size, laterally elongated, with moderately high crown, the base line not much curved on the posterior face; the root subdivided into six or more tumid branches.

This species is founded upon two specimens in the United States National Museum collection, catalogued as Nos. 8104 and 8116, one of which has the crown very excellently preserved, but lacks a part of the root, and the other shows the latter structure in nearly perfect condition, but has the crown somewhat worn and fractured.

Probably to this species should be referred certain low and elongate *Chomatodus*-like teeth occurring in the same formation, by analogy with the association of two very similar types of teeth belonging to *P. concavus* Trautschold, from the Russian Coal Measures. This is in

¹ Jaekel, Otto, Ueber die Organisation der Petalodonten. Zeitschr. Deutsch. Geol. Ges., vol. 51, 1899, pp. 258-298.

accordance with Jaekel's proposed association of parts, already referred to.¹ One such tooth in the National Museum collection is catalogued as No. 8103, and represented of the natural size on plate 8, figure 6.

Formation and locality.—St. Louis limestone (Mississippian); near Alton, Illinois (from the Hambach collection).

Family PSAMMODONTIDAE De Koninck.

Genus PSAMMODUS Agassiz.

The teeth in this genus are quadrate, more or less elongated, rarely nearly square; root much thicker than the crown, and readily detached from the latter; coronal surface generally marked by transverse rugae, complete dentition consisting of from two to four longitudinal rows of pavement teeth in different species, as inferred from their form and marks of mutual contact.

PSAMMODUS PLENUS St. John and Worthen.

Plate 7, fig. 8.

Psammodus plenus ST. JOHN and WORTHEN, Pal. Illinois, vol. 7, 1883, p. 213, pl. 16, figs. 1-4; pl. 17, figs. 1-4.

Psammodus glyptus NEWBERRY (*errore*), Monogr. U. S. Geol. Surv., vol. 16, 1889, p. 210, pl. 19, figs. 7, 8.

The teeth of this species attain large size, and, according to the original authors, it is possible to distinguish between those belonging to upper and lower dental pavements. The form supposed by them to pertain to the upper jaw is described as "subrhomboidal, or of a laterally elongate-trapezoidal outline, gently arched antero-posteriorly." The supposed mandibular teeth "are distinguished by their subquadrangular outline and relatively narrower transverse diameter compared to the length."

According to the interpretation of the authors just quoted the teeth "were ranged in double rows upon the jaws," in the same manner as indicated by them in the case of *P. springeri*, and by Newberry in the case of his so-called *Archaeobatis gigas*, which latter can scarcely be maintained as a distinct genus. There exist, however, certain teeth of *P. plenus* which from their bilateral symmetry are assignable to a median position in the mouth, either above or below; and these were evidently bordered on either side by a row of lateral teeth. Two such teeth which we interpret as indicative of a median unpaired row have already been figured by Newberry under the erroneous designation of *P. glyptus*;² the original specimens are now preserved in the American Museum of Natural History, and have been compared by the writer with other teeth of the same species. The markings

¹ Zeitschr. Deutsch. Geol. Ges., vol. 51, 1899, p. 280.

² Monogr. U. S. Geol. Surv., vol. 16, 1889, pl. 19, figs. 7, 8.

in allusion to which the specific title was bestowed are the result partly of wear and partly of discoloration along concentric lines of growth, as shown by the arrangement of the pores in which the fine tubules terminate.

A number of well preserved examples of this species, all from the St. Louis limestone, are contained in the National Museum collection. An unusually large-sized grinding tooth, collected by G. Ham-bach, is shown of slightly less than the natural size in plate 7, fig. 8.

Formation and locality.—St. Louis limestone; near St. Louis, Missouri; also Illinois and Michigan.

Family COCHLIODONTIDAE Owen.

Genus PSEPHODUS Agassiz.

As in *Cochliodus*, so also in *Psephodus* and closely allied genera, it is probable that a series of helodoid teeth was associated in the same mouth as the large posteriorly placed grinding plates, which latter have resulted from the fusion of a double series on either side of the jaw above and below of narrow and elongate elements. A review of the literature describing the association of *Psephodus* and *Helodus*-like teeth has been given by E. B. Branson;¹ and the conclusion reached by this author is that probably in *Cochliodus* as well as in *Psephodus* no helodoid teeth were present in the complete dentition. Branson's view, which is directly contrary to the prevailing opinion of palaeichthyologists, is based upon his interpretation of the type of the following-named species.

PSEPHODUS LEGRANDENSIS Branson.

Plate 18, fig. 2.

Psephodus legrandensis BRANSON, JOURN. Geol., vol. 13, 1905, p. 24, pl. 1, fig. 2.

The unique specimen serving as the type of this species shows the two series of crushing plates belonging to both halves of the same jaw, and it is supposed by the original author that these elements lie in their undisturbed natural position. It is further supposed by him that they were preceded in front by a pair of small-sized triangular teeth which were in contact with each other along the median line. According to this conjectural reconstruction, as stated by the author,² "no place remains on the jaw for the helodoid teeth which have been so generally considered as forming a component part of the dentition of this genus.

Through the kindness of Dr. Stuart Weller, of the University of Chicago, the present writer has had the privilege of examining the type

¹ Branson, E. B., Notes on some Carboniferous Cochliodonts, with descriptions of seven new species. Journ. Geol., vol. 13, 1905, pp. 20-24.

² Idem, p. 20.

specimen, which is now the property of the Walker Museum (Cat. No. 10038).

To the mind of the present writer the conclusion is irresistible that the anterior and posterior plates present in the right and left hand sides of the jaw have been crowded against one another so as to lie in juxtaposition along the median line as the result of post-mortem deformation. They did not naturally form a compact pavement during life, but the right and left halves were separated, leaving a V-shaped area between them, as in *Cochliodus*. This inferred separation throughout their length would permit of the presence of a series of *Helodus*-like teeth in contact with the front margin of the anterior pair of grinding plates, and it is not necessary to assume that their place was taken by a single pair of small triangular teeth. In a word, the evidence furnished by the type of this species does not appear to be irreconcilable with well established reconstructions of *Psephodont* and *Cochliodont* dentition.

Genus DELTODUS Agassiz.

A discussion of the relations between this genus and *Sandalodus* was published by E. B. Branson a decade ago, in an article entitled Notes on Carboniferous Cochliodonts.¹ We are not able to share this author's view that only a single dental plate is present on each side of the jaw above and below in *Sandalodus* instead of three, as in *Deltodus* and most Cochliodonts. Again, in his discussion of the teeth commonly known as *Deltodus occidentalis*, he undertakes to remove this species to *Sandalodus*, "because there is evidently only one tooth to each ramus of the jaw." This latter statement is merely an assumption resting upon negative evidence, and no proof has yet been adduced to show that the number of dental elements present in the mouth of *Sandalodus* was the same as in *Deltodus*.

DELTODUS OCCIDENTALIS (Leidy).

Plate 8, fig. 3.

Cochliodus occidentalis LEIDY, Trans. Amer. Philos. Soc., vol. 11, 1857, p. 88, pl. 5, figs. 3-16.

Deltodus occidentalis EASTMAN, Bull. Mus. Comp. Zool., vol. 39, 1902, p. 200, pl. 4, fig. 38; pl. 5, fig. 53.

Sandalodus occidentalis BRANSON, Journ. Geol., vol. 13, 1905, p. 27, pl. 1, figs. 8, 9.

Sandalodus occidentalis BRANSON, 30th Ann. Rept. Dept. Geol. Nat. Resources Indiana, 1906, p. 1384, pl. 41, fig. 33.

The complete synonymy of this species is given in the above-cited articles by E. B. Branson and the present writer. In our opinion, however, Doctor Branson is in error in transferring the species to the

¹ Journ. Geol., vol. 13, 1905, pp. 25-27.

genus *Sandalodus*, solely on account of our lack of knowledge of the anterior components of the complete dentition. The form of the large crushing teeth of this species is unmistakably that of *Deltodus*, as may be seen from an inspection of the example shown on plate 8, fig. 3, which is from the St. Louis limestone near St. Louis, Missouri. In geological range the species extends from the Burlington to the St. Louis limestone, inclusive.

ICHTHYODORULITES.

Under this head mention is made of certain interesting dermal defenses of Carboniferous sharks which are preserved in the collection and are worthy of special notice. The interpretation of some of these structures as belonging to primitive Chimaeroids is a novel feature. Generic names founded upon fin-spines and clasping organs are to be understood as used in a provisional sense only.

Genus CTENACANTHUS Agassiz.

In the year 1902 descriptions were published by the present writer¹ of several Kinderhook species of this genus, the types of which had been acquired by the United States National Museum. At the time of their description an exact record of the locality was unobtainable, but at a later date the information was received from Prof. Charles Schuchert that the types of *C. longinodosus*, *C. lucasi*, *C. decussatus*, and *C. solidus*, together with the figured specimens of *C. spectabilis* and *C. venustus*, were collected from the Kinderhook quarries at Le Grand, in Marshall County, Iowa. The formation as exposed in this vicinity is described in the Annual Report of the Iowa Geological Survey, vol. 7, 1896, pp. 221–226.

CTENACANTHUS GRACILLIMUS Newberry and Worthen.

Plate 5, fig. 4; plate 7, fig. 7.

Ctenacanthus gracillimus NEWBERRY and WORTHEN, Pal. Illinois, vol. 2, 1866, p. 126, pl. 13, fig. 3.—ST. JOHN and WORTHEN, Pal. Illinois, vol. 7, 1883, p. 238, pl. 24, fig. 1.

Acondylacanthus occidentalis NEWBERRY, Monogr. U. S. Geol. Surv., vol. 16, 1889, p. 206, pl. 25, fig. 6.

The reasons for uniting the "species" described by Newberry and Worthen as *Peltacanthus* (?) *occidentalis* with *C. gracillimus* of the same authors were pointed out by St. John and Worthen in 1883, and reaffirmed by the present writer in 1902.² Under the designation of *Acondylacanthus occidentalis* a distorted and worn spine from the St. Louis limestone was figured by J. S. Newberry in 1889, evidently through erroneous interpretation. The specimen should properly be referred to the species now under discussion, and a more per-

¹ Bull. Mus. Comp. Zool., vol. 39, No. 3.

² Idem., p. 86.

fect example, from the same horizon and locality, is shown in our plate 7, figure 7. In this, however, as in most examples of this species and of *Physonemus* from the St. Louis limestone, the fine details of tuberculate ornamentation have become obliterated. A smaller and more arcuate spine, or rather, the distal portion of one, presumably of the same species, is shown in plate 5, figure 4. Its curvature and smooth costae are suggestive of *Acondylacanthus attenuatus* Davis, from the Lower Carboniferous limestone of Ireland, but it has a narrower transverse section, and is best regarded as a rather strongly arched example of *C. gracillimus*. It is catalogued as No. 8101.

LIST OF SPECIES OF CTENACANTHUS OCCURRING IN THE MISSISSIPPIAN SERIES.

1. <i>C. coxianus</i> St. John and Worthen	Kinderhook; also Keokuk.
2. <i>C. decussatus</i> Eastman	Kinderhook; also Keokuk.
3. <i>C. depressus</i> Newberry	Kinderhook limestone.
4. <i>C. longinodus</i> Eastman	Kinderhook limestone.
5. <i>C. lucasi</i> Eastman	Kinderhook limestone.
6. <i>C. sculptus</i> St. John and Worthen	Kinderhook limestone.
7. <i>C. semicostatus</i> St. John and Worthen	Kinderhook limestone.
8. <i>C. solidus</i> Eastman	Kinderhook limestone.
9. <i>C. spectabilis</i> St. John and Worthen	Kinderhook limestone.
10. <i>C. varians</i> St. John and Worthen	Kinderhook limestone.
11. <i>C. venustus</i> Eastman	Kinderhook limestone.
12. <i>C. (?) burlingtonensis</i> St. John and Worthen	Burlington limestone.
13. <i>C. gradocostatus</i> St. John and Worthen	Burlington limestone.
14. <i>C. acutus</i> Eastman	Keokuk limestone.
15. <i>C. cylindricus</i> Newberry	Keokuk limestone.
16. <i>C. excavatus</i> St. John and Worthen	Keokuk limestone.
17. <i>C. keokuk</i> St. John and Worthen	Keokuk limestone.
18. <i>C. xiphias</i> St. John and Worthen	Keokuk limestone.
19. <i>C. costatus</i> Newberry and Worthen	St. Louis limestone.
20. <i>C. deflexus</i> St. John and Worthen	St. Louis limestone.
21. <i>C. gemmatus</i> St. John and Worthen	St. Louis limestone.
22. <i>C. gurleyi</i> Newberry	St. Louis limestone.
23. <i>C. harrisoni</i> St. John and Worthen	St. Louis limestone.
24. <i>C. littoni</i> Newberry	St. Louis limestone.
25. <i>C. pellenis</i> St. John and Worthen	St. Louis limestone.
26. <i>C. angulatus</i> Newberry and Worthen	Chester limestone.
27. <i>C. canaliratus</i> St. John and Worthen	Chester limestone.
28. <i>C. similis</i> St. John and Worthen	Chester limestone.

Genus PHYSONEMUS M'Coy.

Syn. *Xystracanthus* Leidy; *Drepanacanthus* Newberry and Worthen.

The earliest and most primitive remains assignable to this "genus" are found in the Kinderhook limestone of the Mississippi Valley, where they are accompanied by small spines of *Stethacanthus*. The Burlington species of both genera are considerably larger than those from the Kinderhook, but they are feebly ornamented, and so too are the

Keokuk species. *Stethacanthus* seems to have attained its maximum size in the stage represented by the Keokuk limestone, as *Physonemus* did in the Burlington; and a marked diminution of size is observable in both genera toward the close of the Mississippian series.

A certain group of large *Physonemus*-like spines is peculiar in that the exerted portion is forwardly curved, instead of backwardly, as in most ichthyodolites, and this feature appeared so anomalous to early authors, like Leidy, Newberry, and Worthen, as in their judgment to warrant a generic separation from *Physonemus*. Hence several species belonging to this category were described under the names of *Xystracanthus* and *Drepanacanthus*. The group of large, forwardly curved spines referred to includes such forms as the so-called *Drepanacanthus gemmatus* Newberry and Worthen, *D. anceps* Newberry and Worthen, *Xystracanthus acinaciformis* St. John and Worthen, *Physonemus gigas* Newberry and Worthen, and the defenses theoretically associated with the teeth of *Polyrhizodus rossicus* by A. Inostranzev¹ and O. Jaekel.² However, it seems preferable to retain all of the "species" represented by these spines within the limits of *Physonemus*, and their forward curvature favors the interpretation of these bodies as head spines and clasping organs such as are developed among recent and fossil Chimaeroids.

Following is a list of the known North American species of *Physonemus*, understood in its broader sense:

1. *P. hamus-piscatorius* Eastman.....Kinderhook.
2. *P. pandatus* Eastman.....Kinderhook.
3. *P. gigas* Newberry and Worthen.....Burlington.
4. *P. gemmatus* (Newberry and Worthen).....Keokuk.
5. *P. stellatus* (Newberry and Worthen).....Keokuk.
6. *P. (?) baculiformis* (St. John and Worthen).....Keokuk.
7. *P. (?) necis* (St. John and Worthen).....Keokuk.
8. *P. arcuatus* M'Coy.....St. Louis.
9. *P. acinaciformis* (St. John and Worthen).....Coal Measures.
10. *P. anceps* (Newberry and Worthen).....Coal Measures.
11. *P. asper* Eastman.....Coal Measures.
12. *P. mirabilis* (St. John and Worthen).....Coal Measures.

PHYSONEMUS GEMMATUS (Newberry and Worthen).

Plates 3 and 4; plate 5, fig. 3.

Drepanacanthus gemmatus NEWBERRY and WORTHEN, Pal. Illinois, vol. 2, 1866, p. 123, pl. 12, figs. 1, 2.

The only published figures of this species are imperfectly preserved spines in which the apical portion is lacking, and the inserted basal part is not completely shown. Two very large (25 cm. high) and well preserved spines belonging to the United States National Museum collection fortunately supplement each other as regards cer-

¹ Travaux Soc. Nat. St. Pétersb., vol. 19, 1888, pp. 1-18, figs. 7-10.

² Zeitschr. Deutsch. Geol. Ges., vol. 51, 1899, p. 281, fig. 5.

tain details; together they acquaint us with the entire outline, including the part inserted in the integument, and also show the characters of the superficial ornamentation more clearly than in the original illustrations of this species.

At first sight it may seem peculiar that the large, obliquely directed denticles seen along the concave margin near the distal extremity should occur on the anterior, instead of posterior, face of the spine. Similar conditions, however, have been noted by St. John and Worthen in the form described by them as *Xystracanthus* [= *Physonemus*] *mirabilis*, and the like is to be observed also in the still more arcuate and forwardly curved spines from the Russian Coal Measures which have been theoretically associated by Inostranzev¹ and Jaekel² with the teeth of *Polyrhizodus rossicus*. We should not hesitate to refer these Russian spines to the genus *Physonemus*, and the interpretation that we should place upon them is to regard them as frontal claspings organs, of the same nature as those in *Squaloraja*, *Myriacanthus*, and recent Chimaeroids.

A single arcuate spine, much weathered and preserved partly in the form of an impression, but apparently referable to this species, was obtained by J. A. Udden in 1914 from Pennsylvanian strata near San Sabo, Texas, at the same locality that yielded the type of *Dicrenodus texanus*. It is contained in the Museum collection (Cat. No. 8108) and is shown in plate 5, figure 3.

PHYSONEMUS ARCUATUS M'Coy.

Plate 5, figs. 1, 2.

Physonemus arcuatus M'Coy, Ann. Mag. Nat. Hist., [2] vol. 2, 1848, p. 117, and Brit. Palaeoz. Foss., 1855, p. 638, pl. 3 I, fig. 20.—EASTMAN, Bull. Mus. Comp. Zool., vol. 39, 1903, p. 280, text-fig. 12.

Spines of this species are of extremely rare occurrence in the Lower Carboniferous of the Mississippi Valley, and few perfect examples have been obtained from either this country or Great Britain. In general the known specimens are denuded of their superficial ornamentation, and the denticles along the concave margin are either worn or broken away. Two specimens which show the tuberculate ornamentation more perfectly than in any previously described example of this species are preserved in the Museum collection, and illustrated in plate 5, figures 1 and 2. They differ somewhat in general outline, one being slender and erect, and having the posterior denticles more strongly developed than in the other, which is more compact and arcuate. Nevertheless, we are not inclined to regard these differences as sufficient to warrant the establishment of a new

¹ Travaux Soc. Nat. St. Pétersb., vol. 19, 1888, pp. 1-18, with plate.

² Zeitschr. Deutsch. Geol. Ges., vol. 51, 1899, p. 281, text-fig. 5. The ornamentation of these spines is suggestive of certain species of *Oracanthus*.

species for the more slender variety, especially in view of the fact that the lower portion of the convex margin is not entire, and some of the posterior denticles have become lost.

Important to note is the fact that the original of plate 5, figure 2, displays very clearly the line of insertion at the base, and the direction of this line would seem to indicate that in this as in other species of *Physonemus*, the distal portion of the spine was forwardly curved. This disposes of the view formerly entertained that the *P. arcuatus* type of head-spine was homologous with the laterally compressed posterior branch of *Erismacanthus* (see pl. 7, figs. 2, 3). That this recurved portion of *Erismacanthus* spines was actually posterior in position follows as a necessary consequence of the interpretation of these organs as frontal claspers. It is probable that in *Physonemus*, as in *Heteracanthus*, the forwardly arched spines were situated immediately behind the head, at the junction with the neck.

Formation and locality.—St. Louis limestone; near St. Louis, Missouri (from the G. Hambach collection).

Genus *ERISMACANTHUS* McCoy.

Of this genus two European and two American species have been described, all of the forms agreeing closely with the *Physonemus* type of frontal spine, but differing from it in that the spines are divaricated; that is, they consist of two branches extending in opposite directions in the same vertical plane. The imperfect ichthyodolulites known as *Gampsacanthus*, *Lecracanthus*, and *Dipriacanthus* appear to be of the same general nature, and may be provisionally regarded as the dissociated anterior branches belonging to *Erismacanthus*. The spines of this genus are somewhat asymmetrical, and were probably located on either side of the head region, whereas the bilaterally symmetrical *Physonemus* type of frontal spine occupied an occipital position.

ERISMACANTHUS FORMOSUS Eastman.

Erismacanthus formosus EASTMAN, Amer. Naturalist, vol. 36, 1902, p. 850, text-fig. 1; Bull. Mus. Comp. Zool., vol. 31, 1902, p. 212, text-fig. 13.

The type of this, the largest known species of the genus, was collected by Dr. G. Hambach in the St. Louis limestone of Missouri, and is now preserved in the collection of the United States National Museum.

ERISMACANTHUS MACCOYANUS St. John and Worthen.

Plate 7, figs. 2, 3.

Erismacanthus maccoyanus ST. JOHN and WORTHEN, Pal. Illinois, vol. 6, 1875, p. 461, pl. 22, figs. 1, 2, 4 (not fig. 3).—EASTMAN, Bull. Mus. Comp. Zool., vol. 31, 1902, p. 211.

The paired frontal claspers described under this name are all of small size, none so far as known exceeding 5 cm. in length. One of

the specimens described by the original authors¹ and doubtfully included by them in this species has since been interpreted by the present writer as belonging to an immature example of *E. formosus*. In the latter species the denticles along the concave margin of the posterior spine are closely approximated; in *E. maccoyanus* they are widely spaced. The United States National Museum collection contains well-preserved specimens of this form from the St. Louis limestone of Missouri (from the G. Hambach collection). One of the most perfect is catalogued as No. 8094, and shown in plate 7, figure 3.

Genus STETHACANTHUS Newberry.

The spines referred to this genus present some resemblance to those of *Physonemus*, and also, in respect to their elongated inserted portion, to certain species of *Oracanthus*, such as *O. vetustus*, presently to be noticed. The maximum size in this genus appears to have been reached in the species known as *Stethacanthus productus*, from the Keokuk limestone of Iowa, the type and only known example of which is preserved in the collection of the United States National Museum. (Cat. No. 3841.)

Two small-sized spines referable to this genus have recently been described by L. Hussakof² from the Waverly of Kentucky under the new specific titles of *S. humilis* and *S. exilis*. They are preserved in phosphatic nodules from one or two localities near Junction City, in Boyle County. It is interesting to compare this occurrence of *Stethacanthus* spines with that of similarly formed spines under precisely the same conditions, within small, hard nodules, in the Caney shale of Oklahoma, at the dividing line between the Mississippian and Pennsylvanian. A portion of such a spine, which cannot be specifically identified with certainty, is among the specimens obtained by Doctor Girty from this horizon, and bears the Museum catalogue number 8110. It is from the locality numbered 6079 in Doctor Girty's Bulletin on the Caney Shale, published by the United States Geological Survey in 1909.

Genus HARPACANTHUS Traquair.

This genus, known hitherto by but a single species, *H. fimbriatus* (Stock), includes small, angularly bent spines, which are best interpreted as frontal claspers corresponding to those of recent male Chimaeroids.

HARPACANTHUS PROCUMBENS, new species.

Plate 7, fig. 1.

Spines resembling those of *H. fimbriatus* but distinguished from them by having a more closely spaced series of conical, recurved,

¹ Pal. Illinois, vol. 6, pl. 22, fig. 3.

² Hussakof, L. Descriptions of four new Palaeozoic Fishes from North America. Bull. Amer. Mus. Nat. Hist., vol. 32, 1913, pp. 245-250.

faintly striated denticles, eight in number, extending for a short distance backward from the distal extremity along what corresponds to the antero-inferior margin in the head-spines of modern Chimæroids; the postero-superior margin opposite the series of recurved denticles gently reflected. A sudden curve in the direction of the spine takes place about midway its length, by which the distal portion of the shaft becomes deflected at right angles from the proximal portion. At the point where the abrupt curvature begins along the antero-inferior margin is seen a prominent semicircular knob-like expansion, which probably served for the attachment of muscles operating to depress the clasper. Surface of spine smooth throughout, but under the lens minute pittings are seen. Cross-section more or less oval, somewhat flattened.

The type and only known example of this species was collected by Dr. G. Hambach in the St. Louis limestone, near St. Louis, Missouri. It was acquired by the United States National Museum a few years ago, and is catalogued as No. 8095.

Genus ORACANTHUS Agassiz.

The spines belonging to this genus often attain a very large size, are much laterally compressed and triangular, rarely elongated and slightly arched; internal pulp-cavity very large, base of insertion usually not very deep, sometimes much extended in horizontal direction. Sides of exserted portion ornamented by large tubercles, with a tendency to become arranged in transverse series, sometimes fused.

ORACANTHUS VETUSTUS Leidy.

Plate 6, fig. 2.

Oracanthus vetustus LEIDY, Proc. Acad. Nat. Sci. Phila., vol. 7, 1856, p. 414, and Journ. Acad. Nat. Sci. Phila., [2] vol. 3, 1856, p. 161, pl. 16, figs. 1-3.—NEWBERRY, Trans. N. Y. Acad. Sci., vol. 16, 1897, p. 285, pl. 22, fig. 3.

The peculiar characters of the much extended base in the spines belonging to this species remained unsuspected until the publication of Newberry's posthumous paper in 1897, in which a single large and nearly complete spine was described and illustrated. In the same article is given a review of the principal literature of the genus, and more complete bibliographical references are brought together in J. W. Davis's monograph on Fossil Fishes of the Carboniferous Limestone (pp. 525-526).

The interesting specimen figured by Newberry was obtained from the Kinderhook limestone near Burlington, Iowa. In the Museum collection are two remarkably perfect specimens from the same horizon at Le Grand, Iowa, one of which is shown in plate 6, figure 2. Some differences are to be noted in the details of ornamentation of the spines that have been referred to this species, but they are not

considered as indicating more than individual variation. The differences will be appreciated from a comparison of the original of our plate 6, figure 2, with the complete specimen figured by Newberry. As regards the nature of the inserted portion, however, the two stand in substantial agreement, both being shallow and greatly elongated. Interesting to observe is the fact that the anterior extremity of the elongated base rises into a tumid "shoulder," recalling the very similar appearance presented by spines of *Stethacanthus*.

Formation and locality.—Kinderhook limestone (Mississippian); Le Grand, Iowa.

ORACANTHUS TRIANGULARIS, new species.

Plate 5, figs. 5, 6.

Spines attaining to a large size, of triangular cross-section in the distal portion, lateral face broad and triangular, resembling in conformation and size the spines of *Xystracanthys mirabilis* from the Coal Measures, except in being less arcuate, and in having more strongly developed conical denticles along the posterior margin. Superficial ornament consisting of large tubercles arranged in more or less regular transverse series, many of them fused together, forming discontinuous ridges.

A few spines presenting the above characteristics are contained in the Museum collection, and, although incomplete, are sufficiently well marked to warrant the establishment of a distinct species to receive them. No other spines are known from the American Lower Carboniferous which exhibit the same broad triangular outline and transversely ridged external surface, due to the coalescence of coarse tubercles in fairly regular series. At the same time the distal extremity is triangular and less laterally compressed in cross-section than is true of most species. The style of ornamentation somewhat resembles that of the type-species, *O. milleri*, and the long and tapering *Physonemus*-like spines which Inostranzev has described from the Russian Carboniferous in accompaniment with the teeth of *Polyrhizodus*. A small fragment from the Chester limestone of Illinois, described by St. John and Worthen as *Oracanthus rectus*, shows a tendency of the tubercles of the exserted portion to become fused into irregular transverse series. The same authors also figure the distal portion of a triangular spine, possibly belonging to the species under discussion, which they erroneously refer to *O. vetustus*.¹ In *O. milleri* the series of ornamented ridges extend obliquely over the sides of the exserted portion.

Formation and locality.—St. Louis limestone, near St. Louis, Missouri. (Cat. No. 8377, U.S.N.M.)

¹ Pal. Illinois, vol. 7, 1883, pl. 24, fig. 2.

Genus EDESTUS Leidy.

Through fortunate discoveries in this country and abroad, our knowledge of the peculiar structures known as the Edestidae has been largely augmented during recent years, and the number of described species increased to more than a score. A review of the existing literature was published by the present writer in 1903,¹ and, a decade later, a further review was contributed by A. Karpinsky,² former Director of the Russian Geological Survey. In the same year appeared an important article by O. P. Hay,³ in which a specimen named by him *Edestus mirus* was declared to afford conclusive proof as to the dental nature of the much-debated segmented structures. This specimen is noteworthy also for having associated with it in the same block of matrix two *Orodus*-like teeth, thus suggesting that the segments of *Edestus* and related genera (*Toxoprion*, *Lisso-prion*, *Helicoprion*) were in reality the fused symphysial teeth of Palaeozoic Cestraciont sharks. More recent contributions to our knowledge of this class of remains are two papers by Karpinsky,⁴ one on the general nature of *Helicoprion*, the other describing a new species and a preliminary account of *Edestus* by Woodward.⁵

EDESTUS HEINRICHI Newberry and Worthen.

Plate 6, fig. 1.

Edestus heinrichi NEWBERRY AND WORTHEN, Pal. Illinois, vol. 4, 1870, p. 350. pl. 1. fig. 1.

One of the largest and best preserved examples of this species has recently been added to the United States National Museum collection, and catalogued under the number 8032. It was collected a number of years ago by Mr. William Metcalf from the Coal Measures of Appanoose County, Iowa, and by him presented to the National Museum in 1914. Its total length is about 33 cm, and the number of segments indicated by separate teeth and sheaths is ten. Besides these, an eleventh and youngest formed segment, not yet consolidated with the fused mass at the time of the creature's death, when it became lost, is indicated by a smooth area on either face of the posterior half of the common base, where the newly formed

¹ Mark Anniversary Volume, pp. 270-289. New York, 1903.

² Karpinsky, A. On *Helicoprion* and other Edestidae: Verh. Kals. Min. Ges. St. Petersburg., vol. 49, 1912, pp. 69-94.

³ Hay, O. P. On an important specimen of *Edestus*, etc. Proc. U. S. Nat. Mus., vol. 42, 1912, pp. 31-38, pls. 1, 2. See also the following by the same author: On the nature of *Edestus* and related genera, with descriptions of one new genus and three new species. Proc. U. S. Nat. Mus., vol. 37, 1909, pp. 43-61, pls. 12-15. The specimens of *Edestus* described in these papers by Doctor Hay are now preserved in the collection of the United States National Museum. They include the types of *Edestus crenulatus*, *E. serratus*, *E. mirus*, and *Lisso-prion ferrieri* Hay.

⁴ Karpinsky, A. Notice sur la nature de l'organe hélicoïdal du *Helicoprion*. Bull. Soc. Ouralienn. Sci. Nat. d'Ekaterinebourg, vol. 35, 1915, pp. 117-145. (Text in Russian and French)—A new species of *Helicoprion* (*H. clerici*). Bull. Acad. Imp. Sci. St. Pétersb., vol. 35, 1916, pp. 701-708. (Text in Russian.)

⁵ Woodward, A. S. A new species of *Edestus* from Yorkshire. Nature, vol. 98, 1916, pp. 102-103,

sheath enveloped the immediately preceding segment. A specimen closely rivalling the one here figured in size and perfection of preservation, but showing a series of nine teeth instead of ten, has recently been acquired by the American Museum of Natural History.

TELEOSTOMI.

Order CROSSOPTERYGII.

The larger number of remains of "fringe-finned ganoids" belonging to the United States National Museum collection consists of Rhizodont scales (14 of them being types described by Cope and others), small Coelacanth, and more or less complete skeletons of Palaeoniscids, all preserved within concretions from the well-known Mazon Creek locality in Grundy County, Illinois. Most of these nodules were formerly contained in the Lacoe collection, acquired by the Museum about twenty years ago. The Lesquereux collection was especially rich in fossils from the Coal Measures of Linton, Ohio, and most of the fishes from this locality are Coelacanth. The so-called ichthyic genus and species, *Mycterops orcinatus* Cope¹ from the Coal Measures of Beaver County, Pennsylvania, is not of vertebrate nature, but founded upon arachnid fragments. The type is catalogued as No. 1977, and another specimen identified as a jugular plate of Coelacanthus by Jaekel, is catalogued as No. 1975.

Family COELACANTHIDAE.

Genus COELACANTHUS Agassiz.

The earliest known representative of this genus is a small form occurring in the basal member of the Upper Devonian near Gerolstein, in Rhenish Prussia, first described by the late Prof. A. von Koenen² in 1895, and recognized as a true Coelacanth by Smith Woodward³ in 1898. A single species, *C. welleri*, has been described by the present writer from the base of the Kinderhook limestone near Burlington, Iowa, and two species of this and a peculiar allied genus, *Palaeophichthys*, have been made known from remains preserved in nodules found at the famous Mazon Creek locality in Illinois.

In the Palaeontology of Ohio (vol. 1, 1873) twenty-seven species of fossil fishes are described from the Coal Measures of Linton, Ohio, and among the number are three belonging to the genus *Coelacanthus*. It is stated by Newberry⁴ that the second most abundant species

¹ Amer. Naturalist, vol. 20, 1886, p. 1029.

² Koenen, A. von. Ueber einige Fischreste des norddeutschen und böhmischen Devons. Abhandl. Ges. Wiss. Göttingen, phys. Cl., vol. 40, 1895, p. 23.

³ Woodward, A. S. Note on a Devonian Coelacanth fish. Geol. Mag., vol. 5, 1898, p. 520.

⁴ Newberry, J. S. The Paleozoic Fishes of North America, Monogr. U. S. Geol. Survey, vol. 16, 1889, p. 213.

occurring at this locality is *Coelacanthus elegans*; and this author remarks:

While perhaps a thousand specimens more or less perfect have been taken from one coal mine there, with the exception of a single one found at Morris (Illinois), no representative of this world-wide genus has been elsewhere seen in America.

At the conclusion of the volume just cited Newberry records this additional observation in regard to *Coelacanthus ornatus*:

This is a small species found at Linton, Ohio, where it is very rare. It is briefly described in the Palaeontology of Ohio, vol. 1, p. 340. Since the publication of that volume I have obtained several other specimens and find that it may be readily identified by its small size, relatively large cranial tubercles, and very thin, delicate scales on which the raised lines are parallel and do not converge as in *C. elegans* and *C. robustus*.

Again, at page 215 of the same work, the author remarks:

Since the notice of the Mazon Creek fishes was published in the report of the Illinois Geological Survey I have received from there a single specimen each of *Eurylepis* and *Coelacanthus*, probably not distinct from those found at Linton.

It thus appears from the writings of Newberry that among the large number of Mazon Creek nodules examined by him, only a single specimen of *Coelacanthus* came under his observation, and that he identified as belonging to *C. elegans*. An allied small species was described by the present writer in 1903, and a supposed new form of large size has recently been discovered by Prof. E. H. Barbour in the Coal Measures of Nebraska.

COELACANTHUS ELEGANS Newberry.

Plate 9, figs. 5, 6; plate 11, figs. 3, 4.

Probably to this species should be referred a half dozen specimens in the United States National Museum collection, all much distorted and imperfect, but agreeing in scale characters and details of ornamentation of cranial plates with *C. elegans*. The fact that Newberry recognized the occurrence of this species at the Mazon Creek locality increases the probability that we have really to do with a form already known from Linton, Ohio, instead of with an undescribed representative of the genus. The specimens figured in the accompanying plates are catalogued under the following numbers, 4381, 4383, 4405, 4438.

Formation and locality.—Coal Measures, Mazon Creek, Illinois.

COELACANTHUS EXIGUUS Eastman.

Plate 10, fig. 1.

Coelacanthus exiguus EASTMAN, Journ. Geol., vol. 10, 1902, p. 538, text fig. 3; Bull. Mus. Comp. Zool., vol. 39, 1903, p. 189, pl. 5, fig. 48.

This is a small-sized species, none of the known examples exceeding 5 cm. in total length. The type and nine other specimens are

preserved in the Peabody Museum; a single specimen is found in the Museum of Comparative Zoology at Harvard College, and two others, both in counterpart and very well preserved, are the property of the United States National Museum. They were formerly in the Lacoe collection, and one of them bears an original label in Newberry's handwriting which reads: "*Palaeoniscus gracilis* New." It is catalogued as No. 4398, and is the original of our plate 10, figure 1. Whereas in the type-specimen only about nine caudal fin-rays are to be counted above and below, this specimen shows at least thirteen in the lower lobe.

Formation and locality.—Coal Measures; Mazon Creek, Illinois.

Genus PALAEOPHICHTHYS Eastman.

This peculiar crossopterygian genus has been provisionally referred to the Coelacanthidæ, but is distinguished from all other members of the family by its elongate, anguilliform body and continuous median fins. In the latter respect an agreement is to be noted with the specialized and problematical genus *Tarrasius*, from the Lower Carboniferous of Scotland, and also with *Conchopoma gadiforme* Kner, from the Lower Permian of Rhenish Prussia. Possibly both *Tarrasius* and *Conchopoma* should be regarded as aberrant Coelacanth.

PALAEOPHICHTHYS PARVULUS Eastman.

Plate 10, fig. 2.

Palaeophichthys parvulus EASTMAN, Ann. Rept. Iowa Geol. Surv., vol. 18, 1908, p. 253, fig. 37.

This is a very small species, attaining a total length of about 5 cm., with a remarkably short head and slender, elongated, anguilliform body. The median fins are continuous, the dorsal arising behind the occiput at a distance equal to about one-and-one-half times the length of the head itself, and the origin of the anal not far behind the middle of the body.

Besides the holotype of this interesting small species, but a single example has come under the writer's observation. It is a specimen formerly in the Lacoe collection, now the property of the United States National Museum, and catalogued as No. 4453. The nodule in which it is contained would seem to have been fractured by natural means and to have been exposed to atmospheric agencies for a considerable time, thus permitting oxidation to take place over the surface with consequent obliteration of a good many structural details. Thus, the precise point of origin of the median fins is indeterminate, the head bones are confused, and although the neural and haemal arches are clearly indicated in the anterior half of the trunk, they cease to be visible in the caudal region. Under the lens it is

possible to recognize faint traces of the squamation, the scales appearing to be very small and covered with delicate longitudinal striae. A portion of the lateral line scale-row is indicated by characteristic raised markings in the posterior part of the trunk, but the caudal extremity is not distinctly shown. Apparently the tail tapered gradually to a point, without being produced into a supplementary caudal fin. The sum total of morphological features presented by this peculiar genus and species is of extreme interest.

Formation and locality.—Coal Measures; Mazon Creek, Illinois.

Family PALAEONISCIDAE.

The earliest representative of this family, and of primitive sturgeons generally, is the genus *Cheirolepis*, remarkable for its small-sized squamation. A single species is known from the Devonian rocks of North America, described by Whiteaves as *Cheirolepis canadensis*. Three species of *Palaeoniscus* have also been founded upon isolated scales occurring in the Upper Devonian of New York State. These have been named *P. antiquus* and *P. reticulatus* Williams, and *P. devonicus* Clarke, but they are more properly assignable to *Rhadinichthys*.

Genus RHADINICHTHYS Traquair.

This genus, apparently indicated by isolated scale patches in the Upper Devonian rocks of this country, and represented by several species in the Lower Carboniferous of New Brunswick and the United States, persists as late as the Pennsylvanian in this country. One species, *R. deani*, occurring at the base of the Waverly, is remarkable for having yielded the first information we possess concerning the organization of the brain and internal ear of any fossil fish. Since the beautifully preserved brain structure of this species was first described,¹ similar remains have been found in the Coal Measures near Lawrence, Kansas,² and less well-preserved specimens are also contained in the collection of fossils from the Caney shale of Oklahoma, already referred to.

One of the specimens from the latter locality showing the internal structure of the head of a small Palaeoniscid, presumably of *Rhadinichthys*, is catalogued as No. 8111, and another showing the greater part of a dentigerous mandible bears the number 8112.

¹ Ann. Rept. Iowa Geol. Surv., vol. 18, 1903, pp. 266-272.

² Twenhofel, W. H., and Dumbor, C. O. Nodules with fishes from the Coal Measures of Kansas. Amer. Journ. Sci., vol. 38, 1914, pp. 157-163. Moodie, R. L. A new fish brain from the Coal Measures of Kansas, with a review of other fossil brains. Journ. Comp. Neurology, vol. 25, 1915, pp. 135-181.

RHADINICHTHYS GRACILIS (Newberry and Worthen).

Plate 9, fig. 4.

Palaeoniscus gracilis NEWBERRY and WORTHEN, Pal. Illinois, vol. 4, 1870, p. 347, pl. 3, fig. 4.

The original illustration of this species, the only one hitherto published, is unsatisfactory in several respects, and the description given is very meager. The distinguishing characters are stated to consist in the smooth rhomboidal scales and remote position of the dorsal and anal fins, which are directly opposed to each other. The illustration which appears in the accompanying plate 9 is reproduced from a photograph of a well-preserved small specimen from the Mazon Creek locality (catalogued as No. 4401). The dorsal, of comparatively few rays, is very remote, and may have been displaced backward by deforming agencies during the fossilization process. The anal comprises 7, and the ventrals 6, well-separated rays. The head parts are not distinctly shown, and the squamation in the anterior part of the trunk has been disturbed. This would seem to be a very rare form in the American Carboniferous. The holotype is preserved in the Peabody Museum of Yale University.

Formation and locality.—Coal Measures; Mazon Creek, Grundy County, Illinois.

Genus ELONICHTHYS Giebel.

An amended diagnosis of this genus has been published by Traquair in his Monograph on the Ganoid Fishes of the British Carboniferous Formations (1877, p. 47). Four species have been described from the Pennsylvanian of the Mazon Creek locality, one of which, *E. peltigerus* Newberry, occurs also at Linton, Ohio. It is not known where the holotype of the latter species is preserved, but the counter-impression of the closely allied *E. hypsilepis* Hay is now the property of the United States National Museum (Cat. No. 4848).

ELONICHTHYS HYPSELEPIS Hay.

Plate 9, fig. 3; plate 10, fig. 3.

Elonichthys peltigerus hypsilepis HAY, Proc. Amer. Philos. Soc., vol. 39, 1900, p. 117, pl. 7.

The material at Doctor Hay's command at the time of establishing this species (regarded by him as doubtfully distinct from *E. peltigerus*) consisted of seven specimens, the most perfect one of which was figured by the author in an excellent photographic reproduction. As contrasted with *E. peltigerus*, Hay noted that in all of the specimens examined by him which were well enough preserved, "the scales in several perpendicular rows just behind the shoulder girdle

are twice as high as long. . . . These high scales gradually become reduced in height, so that those below the dorsal fin are about as high as long."

Doctor Hay remarks further that in his material "the caudal fin is fully one-third the total length of the fish, is deeply forked and has the prolongation of the body covered with pointed scales carried out apparently to its very tip. . . . Along the upper lobe of the tail are numerous striated fulcra. These diminish in height each way from the middle of the lobe." As regards contour of the back the same author observes:

The body appears to have been somewhat elevated immediately under the dorsal fin, the latter being thus lifted somewhat. The sides of this elevation are covered with two rows, an upper and a lower, of narrow, rather long scales, which are directed parallel with the fin rays.

Probably to this species should be referred two specimens belonging to the United States National Museum collection, which are shown of slightly larger than the natural size in the accompanying plates (pl. 9, fig. 3; pl. 10, fig. 3). The form of body is, however, more slender than in the figured example of *E. hypsilepis* and *E. peltigerus*, and the dorsal and anal fins are relatively less elevated and more triangular. The anal fin-rays decrease more rapidly in depth behind, and there is a wider interval between the anal and caudal fins than is the case in those examples of *E. hypsilepis* or *E. peltigerus* which have come under the writer's observation. There is, however, substantial agreement in the number of rays of all the fins, and such differences as have been noted do not appear to warrant the recognition of a distinct species upon the evidence of these examples.

Formation and locality.—Coal Measures; Mazon Creek.

ELONICHTHYS PERPENNATUS Eastman.

Plate 9, fig. 1.

Elonichthys perpennatus EASTMAN, Journ. Geol., vol. 10, 1902, p. 539, text fig. 4; Bull. Mus. Comp. Zool., vol. 39, 1903, p. 190, pl. 5, fig. 49.

This is a very small species, having a total length of less than 4 cm., of which the head occupies a little less than one-fourth. The fins are extremely well developed, the pectoral unusually long, and anal with much extended base line. The fulcra are minute, scales relatively small, obliquely striated; dorsal ridge scales enlarged.

Our knowledge of this gracefully formed and highly ornamented small species has hitherto been confined to the original holotype, now preserved in the Museum of Comparative Zoology at Harvard College. A second example, which seems referable to this species, is that shown in plate 9, figure 1. It is in counterpart, and bears the U.S.N.M. catalogue number 4326. The paired fins have become

lost, together with the greater portion of the caudal, and the recumbent rays of the dorsal have become closely appressed and are in part concealed by matrix. No other examples of this species besides the two that are here mentioned have come to light.

Formation and locality.—Coal Measures, Mazon Creek, Illinois.

Family PLATYSOMATIDAE.

Three species of the genus *Platysomus* have been established upon the evidence of a single specimen each from the Mazon Creek locality, all unsatisfactorily illustrated and described; and a fourth species (*P. palmaris* Cope) has been made known from the Permian of the southern part of Indian Territory. The species founded upon Mazon Creek types have been named as follows: *P. orbicularis*, *P. circularis*, and *P. lacovianus*. The first mentioned of these has been reinvestigated by the present writer and transferred to the genus *Cheirodus*. The holotype of *P. circularis* is preserved in the Museum of Illinois State University at Urbana, and the counter impression of the same specimen in the American Museum of Natural History, labeled in Newberry's handwriting.

Genus CHEIRODUS M'Coy.

In this genus the trunk is rhombic, pectoral fins insignificant, and pelvis absent; the scales are deep and slightly imbricated; margin of mouth toothless, pterygoid and splenial with two denticulated longitudinal ridges.

CHEIRODUS ORBICULARIS (Newberry and Worthen).

Plate 9, fig. 2.

Platysomus orbicularis NEWBERRY and WORTHEN, Palaeont. Illinois, vol. 4, 1870, pl. 3, fig. 1 (no description).

Cheirodus orbicularis EASTMAN, Bull. Mus. Comp. Zool., vol. 39, 1903, p. 193, pl. 5, fig. 52.

It is not known where the holotype of this species is now preserved. A poor figure of this unique specimen was given by the original authors, unaccompanied by any textual description. Upon the evidence of a number of specimens belonging to the Peabody Museum of Yale University, one of which was labeled in Newberry's handwriting as pertaining to this species, an amended definition of it was drawn up by the present writer, which may be here restated:

A small species, attaining a maximum length of about 4.5 cm. Trunk deep, orbicular in outline, the dorsal margin elevated into a prominent peak at about its middle point, and the ventral margin angulated to a somewhat less extent at a point about midway between the branchial apparatus and the narrow caudal pedicle. Facial contour of head steep, cranial plates granulated and striated; the head with opercular apparatus contained about two and one-half times in the total length to the base of the caudal fin. Dorsal and anal fins arising at a considerable distance behind the mar-

ginal peaks, and extending close to the origin of the caudal fin; the latter nearly equilobate, its upper lobe with well-developed fulcra, and its width at distal extremity equalling about one-third the maximum depth of trunk. Dorsal fin with 50 or more rays, caudal and anal each with a somewhat lesser number. (Paired fins not observed.)

Scales ornamented externally with faint longitudinal striae and usually one longitudinal ridge situated near the anterior border of each scale; attached surface coarsely striated, the striae being nearly vertical on the deeper flank scales, but oblique on those situated dorsally and ventrally and in the caudal region. Scales of the anterior part of the trunk arranged in nearly vertical narrow bands, those toward the tail showing a slight downward and backward obliquity, and those at the base of anal fin reflexed forward toward the ventral margin.

A single small specimen, catalogued as No. 4404, fairly well preserved and in counterpart, is contained in the United States National Museum collection (from the R. D. Lacey coll.). One of the halves of this specimen is shown of the natural size in the accompanying plates, and some of the details, such as scale ornament, lateral line, and minute conical teeth are more clearly seen with the aid of a lens in examining the opposite half, which is not figured. For so small a specimen, the dorsal peak at the middle of the back is very prominently elevated, and the appearances do not indicate that this is merely an immature example of some larger form. An understanding of the conformation of the head parts in this and related forms¹ may be gained from consulting the memoir by Dr. R. H. Traquair "On the structure and affinities of the Platysomidae," published in volume 29, 1879, of the Transactions of the Royal Society of Edinburgh.

Formation and locality.—Coal Measures; Mazon Creek, Grundy County, Illinois.

E. FISHES OF THE TRIASSIC SYSTEM.

For the purpose of the present contribution it is not considered practicable to enter into a lengthy or detailed account of the large store of fossil fishes from Mesozoic and Cenozoic horizons belonging to the collections of the United States National Museum, in view of the fact that the majority of these belong to well-known genera, the anatomical structure of which approaches rather closely to that of modern forms, and the systematic position of which is pretty certainly ascertained. A few general remarks on the collection of post-Palaeozoic fishes as a whole, followed by particular notice of certain new or especially interesting species, will be sufficient for this section of the report.

Triassic fishes are extremely well represented in the Museum collection. From the Triassic rocks of eastern North America very extensive collections were made in the Connecticut Valley region dur-

¹ A restoration of the skeleton of *Cheirodus granulatus* (Young) is given in plate 5, figure 1, of this memoir and one of *Platysomus striatus* Agassiz in plate 6, figure 1.

ing the early nineties by Mr. S. Ward Loper, of Middletown, Connecticut, under the direction of Prof. W. M. Davis; and in particular, the specimens obtained by him from one or two localities near Guilford, Connecticut, deserve notice for the excellence of their preservation, and the clearness with which certain doubtful points in the anatomical structure are revealed. Several typical examples from this locality have been selected for illustration in plates 12 and 13.

A number of fine examples of Semionotid fishes from the Newark system of New Jersey (pl. 12, fig. 3), and a few from the Richmond coal field of Virginia, both of Upper Triassic age, are contained in the collection. An exceptionally perfect specimen of *Semionotus elegans* Newberry (Cat. No. 8109) from Boonton, New Jersey, is shown in plate 15, figure 3. The genus *Dictyopyge*, founded upon a nearly complete fish from the Richmond basin, is invested with some historical interest on account of its having been studied by Charles Lyell, Philip Grey Egerton, and Louis Agassiz during the fourth decade of the last century.¹

From the Cordilleran region of this country a large quantity of fish-remains, now in the National Museum collection, was obtained by Dr. C. D. Walcott in the years 1879-80, when exploring the Kanab Canon of Utah and Arizona as his first work in connection with the United States Geological Survey. During the past decade some further remains from the Shinarump group of southwestern Colorado have been obtained by Dr. Whitman Cross, who has shown that there are strong reasons for correlating the Triassic portion of this group, as defined by Powell, with the lower part of the Dolores formation of Colorado. In the course of his discussion of the homotaxial relations of this group, Doctor Cross introduces a section in Kanab Valley, Utah, made by Doctor Walcott in 1879, showing the precise position of the beds (Nos. 11 and 13) whence the fish remains were derived. A reptilian fauna occurs in the Shinarump conglomerate, and the fish beds of the Kanab section occur some hundreds of feet above this member.²

Although the fish-remains from this section are extremely fragmentary, it is possible to recognize with certainty the presence of the genera *Lepidotus* and *Pholidophorus*; and on first examining this material the writer concluded from their general aspect that they indicated a foreshadowing of Liassic conditions.³ During the past year, however, more complete specimens of the genus *Lepidotus* have been studied, the largest and best preserved of which are illus-

¹ Lyell's paper on the coal field of the James River, near Richmond, Va., is found in *Quart. Journ. Geol. Soc.*, vol. 3, 1847. Some interesting correspondence between Lyell and Egerton has recently come to light, and is published in the *Annals of the Carnegie Museum* (vol. 9, 1914, pp. 139-148).

² Cross, W. The Triassic portion of the Shinarump Group. *Journ. Geol.*, vol. 16, 1908, pp. 97-123. A Devonian fish fauna from this region is also mentioned by Dr. Walcott.

³ *Triassic Fishes of Connecticut*. Conn. State Geol. Nat. Hist. Surv. Bull. 18, 1911, p. 35.

trated in the figures at the bottom of plates 12 and 13. Although a precise specific determination is impossible, nevertheless a near comparison may be made with the Semionotid form described by Michael as *Prolepidotus gallineki*, from the Upper Keuper of Silesia.¹ (A series of naturally associated Lepidotid scales is shown in plate 10, figure 7.) The character of the Kanab Valley fish-fauna certainly differs markedly from that of the eastern United States, the differences being probably attributable to the different nature of the sedimentation in the two regions.

A very important suite of material from the Trias of South Africa comprising well-preserved specimens of *Semionotus capensis* Woodward is contained in the collection. The anatomical structure of this species has been carefully investigated by the late Dr. E. Schellwien.² Finally, mention should be made of a small but interesting collection of fossil fishes from the Hawkesbury Series at Gosford, New South Wales, one specimen among the number being a peculiar form of *Belonorhynchus*, presently to be described. The ichthyic fauna of this formation has been investigated principally by Dr. A. S. Woodward.³

Family CATOPTERIDAE Woodward.

This family comprises Triassic fusiform fishes resembling Palaeoniscids in general structure, but having an abbreviate heterocercal tail, and lepidotrichia which only slightly exceed the radials in number. The latter also appear to be formed chiefly of one proximal segment. The ganoid scales are rhombic; the teeth slender and conical.

The family is accompanied in the Trias by other chondrosteans which became eel-shaped (*Belonorhynchidae*) and died out during that period. Still others, which gradually lost their scaly covering and head bones (*Chondrosteus*) continued to survive, and are represented by the sturgeons of the existing fauna. The relations of this family are, therefore, with modern sturgeons rather than with the two surviving genera of Protospondyli, *Amia* and *Lepidosteus*.

Genus CATOPTERUS Redfield.

The type-species of this genus, *C. gracilis*, was described by J. H. Redfield in 1837. A decade later the second known species of *Catopterus* was described by Sir Philip Grey Egerton, when the new genus *Dictyopyge* was established by him upon the evidence of fairly well preserved specimens from the Richmond coal field of Virginia.

¹ Michael, R. Ueber eine neue Lepidosteiden-Gattung aus dem oberen Keuper Oberschlesiens. Zeitschr. Deutsch. Geol. Ges., vol. 45, 1896, pp. 710-729.

² Schellwien, E. Ueber Semionotus Ag. Phys.-Ökon. Ges., Königsberg, 1901.

³ Woodward, A. S. The fossil fishes of the Hawkesbury Series at Gosford. Mem. Geol. Surv. New South Wales, Palaeont., No. 4, 1890.

CATOPTERUS GRACILIS Redfield.

Plate 12, figs. 1, 2; plate 13, figs. 1, 2.

Catopterus gracilis J. H. REDFIELD, Ann. Lyceum Nat. Hist., N. Y., vol. 4, 1837, p. 37, pl. 1.—NEWBERRY, Monograph. U. S. Geol. Surv., vol. 14, 1888, p. 55, pl. 16, figs. 1-3.—EASTMAN, Conn. State Geol. Nat. Hist. Surv. Bull. 18, 1911.

Among the most instructive specimens that have come under the writer's observation for elucidating the much vexed subject of the cranial osteology of this species and genus, first mention should be made of one of the original cotypes of *C. gracilis*, now preserved in the Peabody Museum at Yale University; and scarcely inferior in importance are several small specimens from the Connecticut Valley region belonging to the United States National Museum. Two of these latter, from Durham, Connecticut, are shown in the accompanying plate 12, and a larger one from Guilford, in plate 13, figure 1. The original of plate 13, figure 2, from the Trias of Durham, Connecticut, is of value for illustrating how the depth of body is apparently increased by accidental crushing prior to fossilization. In this specimen it is easy to distinguish the row of dorsal ridge-scales which has been pushed over to one side and occupies a position at some distance below the upper contour line of the fossil. Examples of mechanical deformation of this kind point to the extreme degree of caution that is necessary in attempting to trace the dorsal and ventral contours of crushed specimens of this and the accompanying genus *Semionotus* in the Triassic rocks of North America.

To speak more particularly of the cranial osteology, it must be admitted that scarcely anything can be added to the facts already known. The bones forming the cranial roof are as a rule firmly coalesced and their sutures concealed by the tubercular ornamentation. Apparently the superior border of the orbits is formed by the large-sized frontals, which are bounded behind by the parietals (the latter separated in the median line by a small-sized supra-occipital) and squamosal. The inferior border of the orbit is formed by the expanded posterior portion of the maxilla, which is of relatively large size and decidedly Palaeoniscid-like in form. This plate bears numerous fine, acutely conical teeth, and there is also present a small dentigerous premaxilla, which is often found detached from the other mouth-parts.

Just how the facial plates are arranged in the space lying between the orbit and shoulder-region (clavicle) is difficult to determine. Newberry's interpretation of the elements covering this area in a single specimen studied by him is open to serious question. At least one postorbital is present in its normal position behind the eye, and there may possibly be another, or suborbital, below it. Behind these plates is the area commonly occupied by the operculum and suboper-

culum, but the preoperculum was probably much reduced and nearly concealed by adjacent elements.

Formation and locality.—Upper Trias; Connecticut Valley and New Jersey.

Family BELONORHYNCHIDAE Woodward.

Of this family of Triassic chondrosteans, only a single genus which is capable of satisfactory definition has hitherto been discovered. This is *Belonorhynchus*, represented by about a dozen species. Under the term of *Saurichthys* Agassiz are provisionally included several species which may be generically identical with *Belonorhynchus*, as suggested by Otto Reis,¹ but for the present, following Woodward's example, it seems preferable to retain the established systematic arrangement.

Two representatives of *Belonorhynchus* have been described by A. S. Woodward from the Upper Trias of Gosford, New South Wales. These have been named *B. gigas* and *B. gracilis*, and differ from other known species in the form of dermal scutes and minor details of the fins and scales. From the same horizon and locality a single very peculiar specimen has been obtained which recalls in some respects, such as body contour and character of the remote dorsal fin, the smaller of these species (*B. gracilis*). But the conformation of the head and obtuse, rounded snout does not agree at all with the features which we are accustomed to associate with members of this genus for the corresponding region; and the specimen in question is clearly anomalous in this regard.

The specimen just referred to belongs to the Museum collection, and is shown in plate 14, figure 3. It is embedded in the same slab of sandstone in which are contained several specimens of *Cleithrolepis*, *Semionotus*, and *Dictyopyge*, the whole block being entered under the catalogue number 1842. Unfortunately the condition of the specimen does not permit of a closer identification than to suggest being included as an aberrant representative of the Belonorhynchidae, with much abbreviated snout. Sutures in the cranial shield are not distinguishable, and it would appear as if the actual bone substance had been fractured and exposed to weathering. Under such circumstances we are not warranted in establishing a new genus or species upon the evidence of the solitary specimen before us, but a figure of it is given in the hope that further enlightenment may be at some later time forthcoming.

¹ Geogn. Jahresb., 1891, p. 149.

Family SEMIONOTIDAE Woodward.

A study of the characters of this family shows that the genera included under it are fully developed Protospondyli, that is to say, they belong clearly to that large group of "ganoid" fishes which flourished chiefly during the Triassic and Jurassic periods, but declined rapidly, and is represented at the present day by only two fresh-water genera, *Lepidosteus* and *Amia*. From what ancient stock the Semionotidae and other Protospondyli are descended we do not precisely know, but it may reasonably be inferred that the late Palaeozoic forerunners (*Acentrophorus*, etc.) of the higher suborder were derived from a modified type of chondrosteian. Beyond this, when we inquire as to the origin of the Chondrostei themselves, we find but few facts for our enlightenment. Their origin is at least as ancient as that of the "fringe-finned ganoids," but there is as yet no evidence of a genetic connection between the Chondrostei and cross-opterygians. Enough, however, has been ascertained to show that already in the Trias and probably even earlier the divergence between chondrosteians and Protospondyli was strongly marked.

SEMIONOTUS ELEGANS (Newberry).

Plate 15, fig. 3.

Ischypterus elegans NEWBERRY, Monogr. U. S. Geol. Surv., vol. 14, 1888, p. 37, pl. 7, fig. 2; pl. 10, fig. 1; pl. 14, figs. 1, 2.

Ischypterus modestus NEWBERRY, Monogr. U. S. Geol. Surv., vol. 14, 1888, p. 38, pl. 9, figs. 1, 3.

The original specimens serving for the establishment of this species are now preserved in the American Museum of Natural History in New York. They are nearly complete fishes, but much crushed, and in becoming flattened their characteristic features have become obscured. A large-sized specimen, 17 cm. in total length, and more perfectly preserved than any other example of this species seen by the writer, is contained in the United States National Museum collection (Cat. No. 8109). It is from the Trias of Boonton, New Jersey, and represented in my plate 15, figure 3.

Genus LEPIDOTUS Agassiz.

Syn. *Prolepidotus* Michael.

Numerous species of this genus have been described, but many are imperfectly known. No indications of the genus have yet been reported from this country, with the exception of certain isolated scales from the Kiowa shales (Cretaceous) of Kansas. The following new species is regarded as standing in close relations with *L. gallineki* (Michael), from the Rhaetic of Upper Silesia.

LEPIDOTUS WALCOTTI, new species.

Plate 12, fig. 4; plate 13, fig. 3.

An imperfectly definable robust species of moderate size, attaining a total length of about 30 cm., and exhibiting similar proportions as in *L. minor* and *L. notopterus*; apparently closely related to the Upper Triassic *L. gallineki*. Scales smooth, thick, deeply overlapping, not serrated; clavicle extremely massive; head parts and paired fins not observed; dorsal with about 15 stout rays. (Cat. No. 8119, U.S.N.M.)

It is to be regretted that no complete individuals of this early representative of the genus have yet been discovered. The examples figured in the accompanying plates are the most perfect which are contained in the collection made by Doctor Walcott during his first work in connection with the United States Geological Survey. Although the collections were made more than 35 years ago by Doctor Walcott, in whose honor I have pleasure in dedicating the species, it does not appear that any other person has obtained fish remains from the Utah Trias, nor has any other species of *Lepidotus* been described from this country.

Although fish remains were found by Doctor Walcott in considerable abundance in the Kanab section, no other fossil vertebrates were noticed by him. Besides *Lepidotus*, the only other genus that can be certainly identified among the remains is *Pholidophorus*, evidently of primitive character. A single saurian tooth, perhaps crocodilian, has also been recognized. This latter is significant in view of the fact that a Triassic saurian fauna has been found on the Little Colorado in Arizona, in the San Juan Valley, Utah, not far from the Colorado River, at various points in southwestern Colorado where Doctor Cross has been engaged in survey work for many years, and in the vicinity of Lander, Wyoming, where Dr. S. W. Williston has made collections. In the opinion of Doctor Cross, as stated to the writer in a personal communication, "the horizon exploited by Williston¹ in Wyoming is the same as that which furnished the vertebrates described by Lucas² in Arizona.

The section made by Doctor Walcott in the Kanab Valley, Utah, was first published by Doctor Cross, as already remarked, in 1908. That part of it lying above the Permian is here introduced in order to show the relations of the beds which carry a vertebrate fauna.

SECTION IN KANAB VALLEY, UTAH, MADE BY C. D. WALCOTT, 1879.

Jurassic.

	Feet.
1. White Cliff sandstone, massive, cross-bedded, light gray, broken into five principal belts by horizontal lines of bedding.....	585

¹ Williston, S. W. Notice of some new reptiles from the Upper Trias of Wyoming. Journ. Geol., vol. 12, 1904, pp. 688-697.

² Lucas, F. A. Vertebrates from the Trias of Arizona. Science, vol. 14, 1901, p. 376. A new batrachian and a new reptile from the Trias of Arizona. Proc. U. S. Nat. Mus., vol. 27, 1904, pp. 193-195.

SECTION IN KANAB VALLEY, UTAH, MADE BY C. D. WALCOTT, 1879—continued.

Triassic.

	Feet.
2. Vermilion sandstone; cross-bedded, friable, readily disintegrating, forming the foothills and slope to the more compact sandstones at the northern end of Vermilion Cliff Canyon.....	650
3. Gray and reddish-brown cross-bedded sandstone. Horizontal beds of varying thickness divide the mass into bands of from 25 to 100 feet in thickness.....	300
4. Evenly bedded red sandstones; upper portion an indurated, dark reddish-brown stratum; indurated layers alternate with more friable layers and shales beneath.....	120
5. Massive gray sandstone, cross-bedded; upper portion is a light-gray massive friable bed. The entire mass is subdivided into six principal beds by subhorizontal lines of bedding of a dark, more indurated sandstone. The beds are from 20 to 80 feet in thickness, and may be seen on many steep escarpments along the canon.....	310
6. Solid, partially cross-bedded sandstone, changing from gray to various shades of red.....	20
7. Evenly bedded, light-red sandstone with a thin layer of intercalated gray sandstone.....	20
8. Dark-red sandstone; massive layers alternating with shale, which disintegrates and forms a sloping talus to the gray sandstone beneath.....	180
9. Light-gray sandstone.....	5
10. Bedded sandstone of various shades of red and gray. The layers of sandstone and their shaly partings are irregular in thickness. Scolithus borings occur in great numbers in a friable yellow sandstone. Fragments of vegetable matter and carbonized wood also were seen.....	230
11. Thin layers of sandstone, alternating with bands of fine argillaceous shale holding fish teeth and shells.....	25
12. Massive light-brown sandstone, broken up into thick layers.....	50
13. Alternating layers of sandstone and fine argillaceous shales with fish teeth, etc.	25
A detailed section of 13 is as follows:	
a. Light sandy layers with shaly partings.....	7
b. Fine, smooth, arenaceous and argillaceous shales, drab brown to red with fillets of green. A few fish scales were found	6
c. Fine-grained, light-colored sandstone, 2 to 4 feet in thickness....	4
d. Same as (b), only more fossiliferous.....	8
14. Reddish-brown friable sandstone, broken into layers 1 to 6 feet thick, with shaly partings.....	120
15. Alternating bands of marls and shales, with layers of friable light and reddish-brown sandstone.....	70
16. Reddish-brown sandstone broken up into layers 2 to 7 feet in thickness with a stratum of gray sandstone at the base.....	20
17. Arenaceous and earthy gypsiferous shales; marlites, purple, brown, bluish-green, and green, forming low, rounded foothills and slopes from the Vermilion cliffs to the Shinarump conglomerate.....	650
18. Gray conglomerate and sandstone. Conglomerate formed of small, agatized pebbles and holding silicified wood.....	50
Total of Triassic.....	2,845

Genus *BELONOSTOMUS* Agassiz.*BELONOSTOMUS TENUIROSTRIS* (Agassiz).

Plate 14, fig. 2.

Aspidorhynchus tenuirostris AGASSIZ, Poiss. Foss., vol. 2, pt. 2, 1833, pp. 14, 143, 297.

Belonostomus tenuirostris WAGNER, Abh. Bayer. Akad. Wiss., Math.-Phys. Cl., vol. 9, 1863, p. 691.—VETTER, Mittheil. K. Min.-Geol. Mus. Dresden, pt. 4, 1881, p. 85.—EASTMAN, Mem. Carnegie, Mus., vol. 6, 1914, Nos. 6, 7.

The beautifully preserved example shown in plate 14, figure 2, is of interest for displaying an early growth stage in the young of this species. Its total length being a trifle under 14 cm., it is much the smallest individual yet recorded. The rostrum appears relatively longer than in the adult, and extends for a relatively greater distance in advance of the presymphysial bone; thus proving that in this species, as is also true for *Aspidorhynchus*, the snout and mandible attain their full development at an early stage, subsequently increasing only in thickness. This condition was first noted by Vetter in the type species of *Aspidorhynchus*, and his observations on the jaws of that form are of sufficient interest to be quoted in this connection:

Der Oberkiefer (mit Rostrum) ist hier wie dort aus denselben Elementen zusammengesetzt und im ganzen auch ähnlich gebildet, namentlich ist der Ausschnitt (échancre), in welchen der Unterkiefer hineinpasst und welchen Agassiz ausdrücklich als ausschliessendes Merkmal von *Asp.* hinstellt, auch bei *Bel.* vorhanden, wenn auch noch etwas mehr abgeflacht (was namentlich bei *B. müntzeri* der Fall zu seinscheint); jedenfalls entsteht er hier wie dort durch das Zusammentreffen von Maxillare und Intermaxillare unter sehr stumpfem Winkel und Ueberlagerung des Vorderendes des ersteren durch letzteres. Dagegen ist das Rostrum bei *Asp.* stets erheblich über die Spitze des Unterkiefers hinaus verlängert (beiden jungen Individuen verhält auch die Länge des vorragenden Theils zur ganzen Länge, vom vorderen Orbitalrande angerechnet, wie 2 zu 3, bei den alten wie 1:2,3 bis mindestens 1:2) und dicht vorderselben um ein Viertel seiner ganzen Länge über jene vorragt. Bei *Asp.* gliedert auch die relativ kurze Spitze des Unterkiefers als Praemandibel ab, bei *Bel.* läuft sie continuirlich und sehr schlank aus und der obere Unterkieferrand bildet nur eine schwache Vorragung gegenüber dem "Ausschnitt" des Oberkiefers.

In the same connection the author describes the arrangement of scales on the flanks of *Aspidorhynchus*, and compares it with the conditions observed in *Belonostomus*, a character often difficult to trace in actual specimens. We quote also the following paragraphs:

Es erscheint mir somit wohl zulässig, für alle Arten von *Belonostomus* eine ziemlich gleichartige Form und Anordnung der Schuppen anzunehmen, welche sich wesentlich durch Folgendes auszeichnet: 1) Die Schuppe der Seitenlinie ist durchaus am höchsten. 2) Darüber folgt eine mittelhohe Schuppe von im Groben halbkreisförmigem Umriss. 3) Ueber dieser sitzen nur noch eine oder höchstens zwei kleine dorsale Schuppen. 4) Unter der Seitenlinienschuppe schliesst sich eine mittelhohe Schuppe mit beinahe horizontalem Unterrand an. 5) Die erster der ausserordentlich niedrigen Ventralschuppen ist besonders hinten etwa doppelt so hoch als die folgenden.

Vergleicht man nun damit die für *Aspidorhynchus* typischen Verhältnisse, welche aus zahlreichen Darstellungen hinlänglich bekannt sind, so stößt man auf folgende durchgreifende Unterschiede: 1) Die Seitenlinienschuppe erreicht höchstens dieselbe, meistens eine erheblich geringere Höhe als die darunter folgende. 2) Diese schneidet unten wie die erstere mit schieferm Rande ab. 3) Darunter folgt eine mittelhohe Schuppe, deren hinterer Rand in der Regel länger ist als ihr Längsdurchmesser, und nun erst kommen die niedrigen Ventralreihen. 4) Die über der Seitenlinienschuppe stehende Schuppe ist noch ansehnlich hoch und von regelmässigem Umriß. 5) Darüber kommen mindestens 3 Reihen rhombischer, durchweg stark sculptirter Schuppen.

The scale arrangement in the specimen in hand is not clearly displayed. On the other hand the head bones, teeth of the maxillary and mandible, vertebral rings with their fused arches, and all of the fins, are distinctly visible. The dorsal fin comprises at least 10 rays, and the anal a larger number, apparently about twice as many.

Formation and locality.—Lower Kimmeridgian (Lithographic Stone); Solenhofen Bavaria. The figured specimen is catalogued as No. 23.

Genus NOTAGOGUS Agassiz.

This genus closely resembles *Propterus*, but differs in the non-elongation of the anterior rays of the dorsal fin, which are very widely spaced, and in the less deeply forked character of the caudal fin.

NOTAGOGUS MINUTUS, new species.

Plate 14, fig. 4.

Founded upon a very small (5 cm. long), nearly complete fish, in which the proportions of head and trunk are very similar to those (Cat. No. 8379, U.S.N.M.) of *N. inimontis* Thiollière, but with more slender form of body, the two portions of the dorsal less widely separated, each consisting of about nine rays, and posterior border of scales smooth.

This is one of the smallest known species of *Notagogus*, and it is probable that the unique specimen upon which it is founded is an immature individual. At the same time its characters appear tolerably distinct, and as it cannot be identified as the young of any known form we are warranted in describing it as representing a separate species. Another small form accompanying the holotype in the same horizon is the recently described *N. decoratus*, in which the anterior portion of the dorsal comprises about 10 rays, all widely spaced with the exception of the first three. *N. inimontis* is known only from the Cerin locality in the ancient province of Bugey, France.

Formation and locality.—Lower Kimmeridgian (Lithographic Stone); Solenhofen, Bavaria.

G. FISHES OF THE TERTIARY SYSTEM.

A rich assortment of fossil fishes from the Green River Eocene of Wyoming and other western localities is contained in the collection, and among the number are included several important type speci-

mens. From the Miocene of Florissant, Colorado, quantities of *Amyzon* remains, and from corresponding strata in Esmeralda County, Nevada, large numbers of *Leuciscus* skeletons have been added to the collection. There is also an abundant representation of Eocene and Miocene ichthyic remains from the Atlantic coast region, and from foreign Tertiary horizons mention should be made of a number of fine slabs from the Upper Eocene of Monte Bolca, in northern Italy. In the following pages some of Cope's types which have not previously been figured receive attention, and two or three new species of Tertiary fishes are described.

Family OSTEOGLOSSIDAE.

This family, first appearing in the Eocene, is represented by several modern genera, two of which, *Osteoglossum*¹ and *Arapaima*, are found in South American rivers. *Heterotis* is a tropical African genus. The skull in this group has a distinctly primitive appearance, the superficial bones being thinly covered by skin and having a sculptured surface. The wide nasals, frontals, and parietals meet in the middle line, and the supraoccipital scarcely reaches the surface. Both the premaxilla and maxilla are toothed, and share in forming the margin of the mouth; there is no supramaxilla. The suboperculum is small, often hidden behind the preoperculum, and likewise the interoperculum (Goodrich).

Genus DAPEDOGLOSSUS Cope.

Syn. *Phareodus* Leidy (undefined).

The largest and best known species of this genus is *D. testis* Cope, from the Green River Eocene of Wyoming, of which beautifully preserved specimens exist in the United States National Museum, and in the American Museum of Natural History, New York. One nearly complete skeleton in the latter institution is instructive for having the bones of the skull partly dissociated and displayed to excellent advantage for study. It is catalogued as No. 4587. Through comparison with this specimen it has been possible to identify positively the isolated skull shown in plate 16, figure 1, as belonging to this species. This well-preserved cranium is the property of the United States National Museum (Cat. No. 4916), and has been carefully prepared so as to reveal the underside, freed from the matrix. Its primitive characters are evident, and among surviving genera the resemblance is closest to *Heterotis* of tropical Africa.

¹ For an investigation of the cranial osteology of this genus, see the following: Bridge, T. W. On certain features of the skull in *Osteoglossum formosum*. Proc. Zool. Soc. London, 1895, pp. 302-310.—Ridewood, W. G. On the cranial osteology of the fishes of the families Osteoglossidae, Pantodontidae, and Phractolacmidae. Journ. Linn. Soc. Zool., vol. 19, 1905, pp. 252-282.

Family GONORHYNCHIDAE.

This family, represented in the Upper Cretaceous by *Charitosomus*, and in the middle Eocene by *Notogoneus*, is known to have but one surviving species in the modern fauna. This is *Gonorhynchus greyi*, a specialized form which inhabits the seas off Japan, South Africa, Australia, and New Zealand. It has the head and body covered with small ctenoid scales, and carries a ventral barbel on the prolonged snout. The supraoccipital separates the parietals, the premaxilla

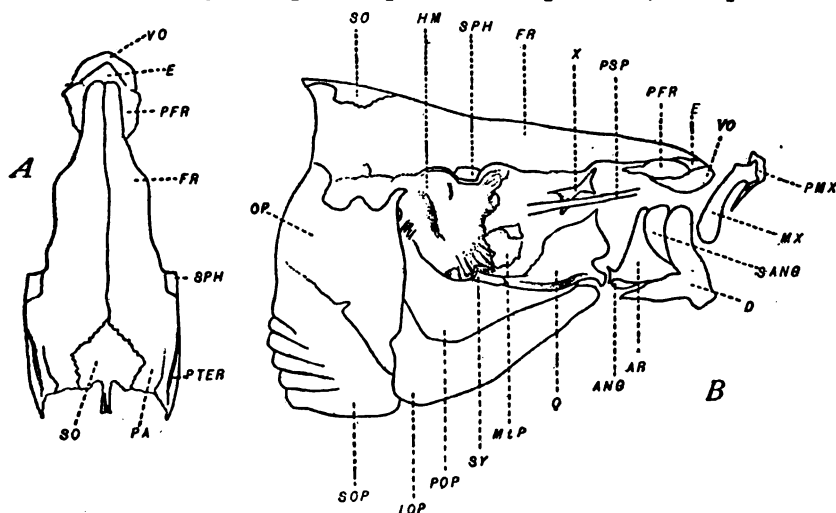


FIG. 9.—NOTOGONEUS OSCULUS COPE. GREEN RIVER EOCENE; TWIN CREEK, WYOMING. DORSAL (A) AND LATERAL (B) ASPECTS OF CRANIUM, ♀. (AFTER L. HUSSAKOF). ANG, ANGULAR; AR, ARTICULAR; D, DENTARY; E, ETHMOID; FR, FRONTAL; HM, HYOMANDIBULAR; IOP, INTEROPERCULUM; MIP, METAPTERYGOID; MX, MAXILLA; OP, OPERCULUM; PA, PARIETAL; PFR, PREFRONTAL; PMX, PREMAXILLA; POP, PREOPERCULUM; PSP, PARASPHENOID; PTER, PTEROTIC; Q, QUADRATE; SANG, SUBANGULAR; SO, SUPRAOCCIPITAL; SOP, SUBOPERCULUM; SPH, SPHENOTIC; SY, SYMPLECTIC; VO, VOMER; X, CHEEK-PLATE.

articulates with the maxilla and excludes it from the margin of the small mouth. According to Smith Woodward the members of this family are related to the Scopelidae.

Genus NOTOGONEUS Cope.

Syn. *Protocatostomus* Whitfield.

The type species of this genus is *N. osculus* Cope, from the Green River limestone of Wyoming, in size attaining a length of about 60 cm. The general structure of the head in this species is indicated in the accompanying text-figure 9, taken from L. Hussakof,¹ who combined in the diagram details shown by three specimens preserved in the American Museum of Natural History.

In plate 15, figure 2, is shown a young individual, which is the smallest known belonging to this species. It adds nothing to our

¹ Bull. Amer. Mus. Nat. Hist., vol. 25, 1908, p. 83.

knowledge of the species in displaying characters already observed, but it is interesting for the same reason that the young of other species are interesting to which we have called attention in the present article and figured in plate 14—namely, immature examples of *Belonostomus*, *Notagodus*, and *Acanthurus* (pl. 14, fig. 1) (the last from the upper Eocene of Monte Bolca, Italy). These young individuals acquaint us with early growth stages of the several species in question, and enable us to compare the relative proportions of different parts at different periods in the life history for the species in question. The original of our plate 15, figure 2, is catalogued as No. 6037.

Formation and locality.—Green River Eocene, Wyoming.

Family CYPRINODONTIDAE.

In this family, which includes forms of extremely small size, the mouth is protractile, teeth are present on the jaws and pharyngeals, but rarely on the palate; the palatoquadrate arch is more or less reduced; and the supraoccipital extends forward to the frontals, separating the parietals in the median line. Only two or three extinct genera are known with certainty. Modern forms are mostly confined to fresh waters, but a few are found in brackish water and on the seacoast.

Genus GEPHYRURA Cope.

In July, 1891, E. D. Cope published descriptions of five new species of fossil fishes from a supposed Lower Tertiary horizon in Ree Hills, South Dakota. Three of the forms were regarded as typical of new genera, which were named by the author *Gephyrura*, *Proballostomus*, and *Oligoplarchus*; the taxonomic relations of the first two being with the cyprinodonts, and of the last named with the percoids. The holotypes of these new genera and species are now preserved in the American Museum of Natural History and have recently been studied by the present writer. Although the type of *Gephyrura* was referred by Cope with some hesitation to the cyprinodonts, there does not appear to be the slightest doubt as to the correctness of this association; and the unique specimen available for study evidently stands in close relations with the new cyprinodont genus immediately to be described from the Lahontan beds near Hazen, Nevada. For convenience of reference, however, we may first restate the specific characters of *G. concentrica*, as defined by Cope.

GEPHYRURA CONCENTRICA Cope.

Gephyrura concentrica COPE, Amer. Naturalist, vol. 25, 1891, p. 654.

Char. specif.—The only specimen is broken vertically across the middle, and the posterior half shifted so as to lie immediately below its proper position. It appears that little or no part of the fish has been lost. Radii, P. 9; D. 9; C. 6-16-8; A. II 11.

V. 1-6; vertebrae, 10-18. Scales in twelve longitudinal rows between dorsal and ventral fins, and equal in number to the vertebrae on the longitudinal line, or 28. Head covered with scales; five in a vertical line on the operculum. The dorsal, pectoral, and ventral fins are rather small. The caudal fin is probably not much forked, if at all. The orbit is large, but its outlines are not well preserved. The head enters the total length four and a quarters times to the base of the caudal fin-rays, and slightly exceeds the depth at the ventral fins. Total length, 61 mm.; length of head, 15 mm.; length to base of ventral fin, 24.5 mm.; length to base of anal fin, 30 mm.; depth at ventrals, 14 mm.; depth at caudal peduncle, 6 mm.

Formation and locality.—Oligocene (?) Ree Hills, South Dakota.

PARAFUNDULUS, new genus.

A genus closely related to existing killifishes, and also to the extinct *Gephyrura*, but distinguished from the latter chiefly by its smaller and less conspicuously marked scales, larger number of dorsal fin rays, and presence of a hypural bone. Caudal fin gethyrocercal.

Type of the genus.—*Parafundulus nevadensis*, new species.

PARAFUNDULUS NEVADENSIS, new species.

Plate 16, fig. 2; plate 17; plate 18, fig. 3.

A small form attaining a total length of about 5.5 cm., in which the length of the head and opercular apparatus is contained three and one-half times. Dorsal comprising 11 rays, supported by an equal number of interspinous bones, and inserted opposite a point midway between the pelvics and anal. Scales small and thin, with fine concentric markings, crossed by a few inconspicuous radiating proximal striae.

Fin formula: D. 11; C. 23; R. 10; V. 9; P. 11-12.

The specimen (Cat. No. 8120) selected as type of this species is photographed of the natural size in plate 16, figure 2, and a drawing of it is reproduced in plate 18, figure 3. It is the most perfect of several that were obtained in 1905 by Mr. N. H. Darton, in strata of very white clay near Hazen, Nevada, which have received the name of Lahonton beds. From the same locality a single species of stickleback, known as *Gasterosteus doryssus* Jordan, was described almost simultaneously in 1907 by Drs. D. S. Jordan¹ and O. P. Hay.² Besides the type several other examples of this species, shown in plate 17, were collected by Mr. Darton at the same locality, and are now preserved in the collection of the United States National Museum. The writer is indebted to his colleague, Mr. John Treadwell Nichols, of the American Museum of Natural History, for helpful suggestions in regard to comparing this form and its scale characters with the existing *Fundulus*.

Formation and locality.—Lahontan beds; near Hazen, Nevada.

¹ Pub. Univ. Cal., vol. 5, 1907, No. 5, p. 131, figs. 25, 26; Smiths. Misc. Coll., vol. 52, 1910, p. 117.

² Proc. U. S. Nat. Mus., vol. 32, 1907, pp. 271-273, figs. 1-3.

Family CYPRINIDAE.

Genus AMYZON Cope.

This is an extinct genus related to modern suckers, but with a more extended dorsal fin. It is stated by Woodward to be "scarcely distinguishable from *Sclerognathus*, but with pharyngeal bones expanded behind." Mr. J. T. Nichols has pointed out to the writer that the Canadian species *A. brevipinne* approaches very closely to existing buffalo fishes of the genus *Ictiobus*; and Cope, in his description of *Amyzon*, has remarked upon its near relations with *Bubalichthys*.

AMYZON BREVIPINNE Cope.

Plate 19, figs. 1, 2.

Amyzon brevipinne COPE, Proc. Acad. Nat. Sci. Phila., 1893, p. 402.—LAMBE, Trans. Roy. Soc. Canada, vol. 12, 1906, pp. 151-155, pl. 1.

The type of this species was obtained from beds in British Columbia supposed to be of late Eocene or early Miocene age. It has never been figured, but one small specimen from Horsefly River, British Columbia, and another belonging to a different species (not of *A. commune*, however), have been described and illustrated by Dr. L. M. Lambe within recent years.

To this species should probably be referred two specimens figured in plate 19, which were collected in 1910 by Mr. J. B. Umpleby from beds of supposed Lower Miocene age, near Republic, Washington. These are now the property of the National Museum, and are catalogued as Nos. 81 and 8117. They are the largest and best preserved examples of this species yet brought to light.

Genus LEUCISCUS Cuvier.

LEUCISCUS TURNERI Lucas.

Leuciscus turneri LUCAS, 21st Ann. Rept. U. S. Geol. Surv., 1901, pt. 2, pp. 223-224, pl. 31.

The holotype of this species (Cat. 4302a), and a large number of well-preserved specimens from the Esmeralda formation in western Nevada, are contained in the United States National Museum collection. The age of these beds is discussed by H. W. Turner in the Twenty-first Annual Report of the United States Geological Survey, 1899-1900 (part 2, pp. 203-205), and in the same volume (pp. 209-220) the fossil plants occurring in this formation are described by F. H. Knowlton.

Nothing can be added to our knowledge of the species beyond the information already contributed by Dr. F. A. Lucas.¹ There may be compared with it, however, a specimen that apparently belongs to

¹ 21st Ann. Rept. U. S. Geol. Surv., 1901, pp. 223-224, and Proc. U. S. Nat. Mus., vol. 23, 1900, pp. 333-334, pl. 7.

this or a closely related species, from the Madison Valley, Montana, which is shown of slightly larger than the natural size on plate 18, figure 4. Mr. Earl Douglass, who collected a small number of fish remains from this locality, is of the opinion that the strata containing them is of Oligocene or Lower Miocene age. An undetermined species of *Osmerus* is apparently indicated by the original of plate 18, figure 5, from the same locality as the last. Both are preserved in the Carnegie Museum in Pittsburgh. In plate 19, figure 3, is shown an example of an undetermined cyprinodont species from the Tertiary of Mexico.

Family SILURIDAE.

Fossil representatives of this family are uncommon, and for the most part imperfectly preserved. Fragmentary remains from the Lower Eocene have been assigned to *Arius*, and others from the Lower Miocene to *Ameiurus*. The undermentioned specimen is the only nearly complete example of the latter genus that has been discovered in the fossil state.

Genus AMEIURUS Rafinesque.

AMEIURUS PRIMAEVUS, new species.

Founded upon a unique specimen without locality label, but as far as may be judged from the appearance of the matrix it would seem to have been derived from the Green River Eocene of Wyoming. Clearly related to the more generalized and representative genus of modern North American catfishes *Ameiurus*, it differs from all living species in its shorter anal, consisting of only 12 rays, and in this respect resembles the more specialized genus *Leptops*, known by a single species. It is shown in plate 20.

The holotype of this species is a nearly complete skeleton having a total length to the base of the caudal fin of 21.5 cm., in which the length of the head including the supraoccipital process is contained three times. Head broad behind, not much contracted forwards; surface sculpture consisting of anastomosing rugae and pittings as in the recent *A. catus*; orbits small; fontanelle situated just before the origin of the supraoccipital process. Maximum breadth of head in its flattened condition equal to its length. Vertebrae 29 in number, with strong neural spines. Dorsal fin between the pectorals and ventrals, with about six branched rays of moderate length (its spine broken away). Pectoral spines strong, smooth, less than half as long as the head. Ventrals with eight, anal with apparently not more than twelve rays. Rays of caudal fin mostly broken away, but the curved line formed by their articulation with hypural fin-supports indicating that the fin was rounded. (Cat. No. 8122, U.S.N.M.)

This is an extremely interesting and well-preserved specimen, save that the caudal fin is for the most part lacking, and the dorsal has been folded under the neural spines and partly concealed by them.

The supraoccipital process has been shifted slightly to one side of the anterior vertebrae, and was apparently not in direct connection with them. The relations are evidently very close with the existing *A. catus*, excepting as regards the smaller number of anal fin rays and nonserrate character of the pungent pectoral spines. With respect to the short-based anal fin, it may be said that although only a dozen rays are now visible in the specimen, a few more may have been present in advance of those now to be seen, but became lost or were cut away by careless trimming of the specimen along the ventral margin. In fact, one can almost certainly distinguish, although faintly, traces of a few interspinous bones in advance of the foremost anal fin ray now appearing in the specimen. At the most, however, we must admit that this fin was shorter than in existing species of *Ameiurus*, but otherwise the differences are of but minor character.

The latter observation appears the more remarkable if we accept the view as correct that the fossil before us is of Middle Eocene age. How closely *Rhineastes*, from the Green River Eocene, agrees structurally with modern species of Silurids, cannot be determined, as it is known only by fragmentary remains. But in the nearly complete skeleton which we are now considering we find evidence that the typical expression of the genus *Ameiurus*, as we know it to-day, was already attained in the early Tertiary, and has persisted unchanged ever since.

Formation and locality.—Supposedly from the Green River Eocene of Wyoming.

Family PERCIDAE.

This family and the small one known as Aphredoderidae, now nearly extinct, are included in Doctor Gill's superfamily Percioidea. The types of most of Cope's species of *Amphiplaga*, *Asinepos*, *Erismatopterus*, and *Trichophanes*, belonging to the Aphredoderidae, are preserved in the collection of the United States National Museum. The nearly complete example of *Trichophanes foliarum* Cope, which has recently been figured by T. D. A. Cockerell,¹ is the property of the American Museum of Natural History, and the types of Cope's species of *Mioplosus* are divided between this institution and the National Museum.²

Fossil perches in the restricted sense of the term are represented in the Tertiary rocks of this country by the genera *Mioplosus*, *Pliolarchus*, and *Oligoplarchus*. The first of these differs from *Perca* in having fewer vertebrae and a spineless operculum. It is known by several species in the Green River Eocene, of which the genotype, *M. labracoides* Cope, is the most common. Probably the so-called *M.*

¹ Amer. Naturalist, vol. 42, 1908, p. 571.

² For lists of specimens see the published catalogues of type and figured specimens belonging to these museums, already referred to. The parts dealing with fishes were published in 1907 and 1908, respectively.

longus is only a young example of this form, the individuals of which show a considerable amount of variation. In plate 21 is shown a large (44 cm. long) and well-preserved specimen which may be referred to *M. labracoides*, notwithstanding the fact that it displays one abdominal and one caudal vertebra in excess of the normal number occurring in the type-species. The type of *M. multidentatus* Cope has not been figured. It is preserved in the American Museum of Natural History.

Formation and locality.—Green River Eocene; Wyoming.

Genus **PLIOPLARCHUS** Cope.

This extinct genus, closely related to *Mioplosus*, is represented by three Lower Tertiary species, of which only one, *P. whitei* Cope, has been illustrated. The differences between this species, which is the type, and *P. sexspinosus*, are stated to consist in the more numerous spinous, and less numerous soft rays, of the dorsal and anal fins. In *P. whitei* the radial formula is:

D. IX-12; C.-17-; A. V-14; V. ?; P. 13.

And in *P. sexspinosus* it is:

D. X-13; C. -17-; A. VI-9.

In *P. septemspinosus* the formula is given as:

D. XI-?; A. VII (?)-12.

PLIOPLARCHUS SEXSPINOSUS Cope.

Plate 15, fig. 1.

Plioplarthus sexspinosus COPE, Amer. Journ. Sci., vol. 25, 1883, p. 416; Rept. U. S. Geol. Surv. Terr., vol. 3, 1884, p. 729.

In the original description it is stated that "this species is represented by two specimens, both of which lack the head and body anterior to the dorsal fin." These specimens are now in the United States National Museum collection, and one of them, marked "type," is catalogued as No. 4236. It is from the Lower Tertiary, perhaps Miocene, near Sentinel Butte, in Billings County, North Dakota. A much more complete example, also from the type locality, is shown in our plate 15, figure 1. In it the anal fin is seen to have six spinous and twelve soft rays. The specimen bears the catalogue number 8118.

Formation and locality.—Miocene (?); top of Sentinel Butte, North Dakota.

PLIOPLARCHUS SEPTEMSPINOSUS Cope.

Plate 22.

Plioplarthus septemspinosus COPE, Amer. Naturalist, vol. 23, 1889, p. 625.

This species was established by Cope upon the evidence of four distorted and mutilated specimens from shales near Van Horn's ranch, on the John Day River, Oregon, the strata whence they were

obtained being supposed by Cope to be approximately equivalent to the Amyzon beds. The specific characters are thus diagnosed by the author:

The mouth is small, and opens obliquely upward. Premaxillary and dentary teeth in several rows. Size larger than that of the *P. whitei* Cope, and the scales are less numerous and of larger size. The spinous rays are less numerous than in that species and the *P. setzpinosus*. Formula: D. XI.—?; A. VII.—? 12; the soft anal rays at least 12, possibly more. Scales in five or six rows above the vertebral column and in 10 or 12 below it. Radiating ridges of proximal portion strong; disk and distal portion scarcely roughened. Caudal vertebrae, 15.

The specimens are all too much injured to permit of complete measurements. The largest measures from the end of the muzzle to the base of the caudal fin 260 mm., and 90 mm. in depth at the vertical fins. The last dorsal spine measures 36 mm. A lateral dorsal scale is 6 mm. in length.

Family CICHLIDAE (Chromidae).

Known in the fossil state by a single Eocene genus, the numerous modern forms are tropical and subtropical fresh-water fishes. There is no ingrowth from the suborbitals forming a suborbital shelf, no supramaxilla, and a suture divides the lower pharyngeals.

Genus PRISCACARA Cope.

This, the only known fossil genus, differs from all existing members of the family in the possession of vomerine teeth. Small, conical teeth are present along the margin in both jaws, and the preoperculum is serrated. According to Haseman,¹ there are six branchiostegal rays.

Of the seven species which have been described by Cope from fresh-water Tertiary formations in this country, the types of six are preserved in the United States National Museum. These species, according to Cope, fall into two sections. "In the first," he writes, "the ventral spine is very strong, and there are but 10 or 11 soft dorsal radii: here belong *P. serrata*, *P. cypha*, *P. oxyprion*, and *P. testudinaria*. In the second, the first ventral spine is weak and slender, and there are 13 or 14 radii of the second dorsal fin; in this division belong *P. liops*, *P. pealei*, and *P. clivosa*.

PRISCACARA DARTONAE, new species.

Plate 23.

A species of large size, attaining a total length of 28 cm. to base of caudal fin, in which the length of the head and opercular apparatus is contained two and three-fourths times. Maximum depth entering into total length 2.7 times. Dorsal contour strongly arched and frontal profile rising steeply to a point just in front of the origin of the dorsal fin; the vertebral column arched anteriorly so as to be directed

¹ Haseman, J. D. The relationship of the genus *Priscacara*. Bull. Amer. Mus. Nat. Hist., vol. 31, 1912, pp. 97-101.

nearly parallel to the dorsal contour. Spinous rays of all the fins relatively weaker than in other known species, those of the dorsal fin not quite equalling the soft rays in length; pectoral fin rays when appressed against the ventral margin reaching to the anal; the latter having the second and third spines about equally developed. Vertebrae: 10 abdominal, and 15 caudal. Radial formula:

D. XI.-11; A. III.-8; V. I-5.

The holotype upon which this species is founded is a large (35 cm. long) and handsome specimen, excellently preserved, and remarkable for its steep facial profile and correspondingly increased depth of body as compared with other species. The vertebral column is also prominently flexed anteriorly, and the number of vertebrae is greater than in related species. The number of spinous rays in the dorsal fin is also greater by one than in either *P. serrata* or *P. oxyprion*, and the the number of rays in the anal fin the same as in these species. The spinous rays of all the fins are less robust than in any described species, and those of the dorsal fin are relatively shorter. In form of body this species stands in rather close agreement with *P. clivosa* Cope, which is smaller, and differs in fin characters and number of vertebrae. In other respects the new species shows considerable resemblance to *P. oxyprion*, in particular the number of anal and pelvic fin-rays being the same. One may say that it is intermediate in respect to the majority of its characters between these two species, *P. oxyprion* and *P. clivosa*; and although attaining as large a size as the type-species, *P. serrata*, it is much less formidably armed. Correlating with a weaker defense, it was probably of less active habits.

The writer takes pleasure in naming this species in honor of his friend, Mrs. N. H. Darton, of Washington, who with her husband has collected fish remains from western Tertiary horizons. (Cat. No. 2381, U.S.N.M.) To Mr. Darton the writer is indebted for the opportunity of studying the remains collected from near Hazen, Nevada (see p. 291, under *Parafundulus*) and from the Black Hills uplift of South Dakota.

Formation and locality.—Green River Eocene, near Fossil, Wyoming.

UNCERTAIN PLACE.

Genus ISCHYRHIZA Ledy.

The peculiar teeth first described by Ledy from the Cretaceous of New Jersey under this name, and since found in the Eocene of the Atlantic Coast region and in the Fox Hills Cretaceous of New Mexico, were conjectured by Cope to have belonged to teleost fishes, allied to the Esocidae. He also proposed that certain coalesced caudal vertebrae ("hypural fans") accompanying the Cretaceous teeth and occurring also in the Eocene of Maryland and South Carolina, should

be theoretically associated with the same genus. A somewhat different view has been expressed by the present writer,¹ who suggests that the Cretaceous fans may have belonged to *Protosphyraena* or some similar form, and that the Tertiary fans, which differ from the Cretaceous in having the terminal centrum attached, properly belong to swordfishes.

In accordance with this latter interpretation, the large fan which is shown in plate 16, figure 3, from the Phosphate Beds of South Carolina, may be provisionally assigned to *Xiphias*, and the detached tooth of *I. mira* Leidy shown in plate 11, figure 2, from the Ripley Group (Cretaceous) near Dumas, in Tippah County, Mississippi, should be assigned to a different taxonomic position. Cope's conjecture that the teeth of *Ischyryza* indicate affinity with the Esocidae is accepted by O. P. Hay and others, and seems plausible. The type of *I. mira*, together with other specimens from New Mexico, are preserved in the American Museum of Natural History

EXPLANATION OF PLATES.

PLATE 1.

Heteracanthus uddeni Lindahl, p. 245.

Head-spine, natural size. Devonian (Cedar Valley limestone); Johnston County, Iowa.

PLATE 2.

FIG. 1. *Dinichthys tuberculatus* (?) Newberry, p. 249.

Dorsomedian plate, natural size. Devonian (Chemung); Warren County, Pennsylvania.

FIG. 2. *Sauripterus taylori* Hall, p. 252.

Naturally associated cranial roofing plates, natural size. Devonian (Catakill); near Blossburg, Pennsylvania.

PLATE 3.

Physonemus gemmatus (Newberry and Worthen), p. 263.

Spine, $\times \frac{1}{3}$. Mississippian (Keokuk limestone); near Keokuk, Iowa.

PLATE 4.

Physonemus gemmatus (Newberry and Worthen), p. 263.

Spine, $\times \frac{1}{3}$. Mississippian (Keokuk limestone); near Keokuk, Iowa.

PLATE 5.

FIGS. 1 and 2. *Physonemus arcuatus* M'Coy, p. 264.

Two spines natural size. Mississippian (Keokuk limestone); Keokuk, Iowa.

FIG. 3. *Physonemus gemmatus* (Newberry and Worthen), p. 264.

A much weathered, arcuate spine, natural size. Pennsylvanian; near San Saba, Texas.

¹ Maryland Geol. Survey, Eocene, 1901, p. 111. Miocene volume, 1904, p. 93.

FIG. 4. *Ctenacanthus gracillimus* Newberry and Worthen, p. 261.

Spine, natural size. Mississippian (St. Louis limestone); near St. Louis, Mo.

FIGS. 5 and 6. *Oracanthus triangularis*, new species, p. 268.

Spine, natural size. Part of spine? $\times \frac{1}{2}$. Mississippian (St. Louis limestone); near Alton, Ill.

PLATE 6.

FIG. 1. *Edestus heinrichi* Newberry and Worthen, p. 269.

A large, well-preserved series of fused dental segments $\times \frac{1}{2}$.
Pennsylvanian; Appanoose County, Iowa.

FIG. 2. *Oracanthus vetustus* Leidy, p. 267.

Dorsal spine, $\times \frac{1}{2}$. Mississippian (Kinderhook); Le Grande, Iowa.

PLATE 7.

Harpacanthus procumbens, new species, p. 266.

FIG. 1. Fin-spine, natural size.

Mississippian (St. Louis limestone); St. Louis, Missouri.

Erismacanthus maccoyanus St. John and Worthen, p. 265.

FIGS. 2, 3. Fin spines, natural size.

Mississippian (St. Louis limestone); St. Louis, Missouri.

Dicrenodus texanus, new species, p. 256.

FIG. 4. Tooth, natural size.

Pennsylvanian; near San Saba, Texas.

Sauripterus taylori (?) Hall, p. 252.

5. (?) Basisphenoid, natural size.

Devonian (Catskill); near Blossburg, Pennsylvania.

Coccosteus, species, p. 246.

6. Antero-ventro-lateral plate, natural size.

Devonian (Elbert formation); near San Juan, New Mexico.

Ctenacanthus gracillimus Newberry and Worthen, p. 261.

7. Fin-spines, natural size.

Mississippian (St. Louis limestone); St. Louis, Missouri.

Psammodus plenis St. John and Worthen, p. 258.

8. A large-sized dental plate, natural size.

Mississippian (St. Louis limestone); near St. Louis, Missouri.

PLATE 8.

Polyrhizodus grandis, new species, p. 257.

FIGS. 1, 2. Dental plates, natural size.

Mississippian (St. Louis limestone); near Alton, Illinois.

Deltodus occidentalis (Leidy), p. 260.

FIG. 3. Dental plate, natural size.

Mississippian (St. Louis limestone); near St. Louis, Missouri.

Polyrhizodus concavus (St. John and Worthen), p. 257.

4. Dental plate, natural size.

Mississippian (St. Louis limestone); near St. Louis, Missouri.

Dipterus angustus (Newberry), p. 247.

5. Impression of dental plate, natural size.

Devonian (Chemung); Bradford County, Pennsylvania.

Chomatodus-type of tooth, p. 257.

6. Associated with *Polyrhizodus grandis*. Natural size.

Mississippian (St. Louis limestone); (?) near St. Louis, Missouri.

Cladodus spinosus Newberry and Worthen, p. 254.

7. Tooth, natural size.

Dinichthys pustulosus Eastman, p. 248.

8. Posterior process of dorsomedian plate, natural size.

Upper Devonian; Johnson County, Iowa.

PLATE 9.

Elonichthys perpennatus Eastman, p. 275.

FIG. 1. An incomplete example, natural size.

Pennsylvanian; Mazon Creek, Illinois.

Cheirodus orbicularis (Newberry and Worthen), p. 276.

2. A fairly well-preserved specimen, natural size.

Pennsylvanian; Mazon Creek, Illinois.

Elonichthys hypsilepis Hay, p. 274.

3. A nearly complete specimen, $\times \frac{1}{2}$.

Pennsylvanian; Mazon Creek, Illinois.

Rhadinichthys gracilis (Newberry and Worthen), p. 274.

4. A well preserved small specimen, $\times \frac{1}{2}$.

Pennsylvanian; Mazon Creek, Illinois.

Coelacanthus elegans (?) Newberry, p. 271.

FIGS. 5, 6. Two distorted incomplete skeletons, $\times \frac{1}{2}$.

Pennsylvanian; Mazon Creek, Illinois.

PLATE 10.

Coelacanthus exiguus Eastman, p. 271.

FIG. 1. A well-preserved example, $\times \frac{1}{2}$.

Pennsylvanian; Mazon Creek, Illinois.

Palaeophichthys parvulus Eastman, p. 272.

2. A specimen with the structural details impaired by oxidation, $\times \frac{1}{2}$.
Pennsylvanian; Mazon Creek, Illinois.

Elonichthys hypsilepis Hay, p. 274.

3. Skeleton in nodule showing fin structure, natural size.
Pennsylvanian; Mazon Creek, Illinois.

Cladodus aculeatus, new species, p. 255.

4. A tooth, $\times \frac{1}{2}$.
Mississippian (Caney shale); Antlers Quadrangle, Oklahoma.

Arthrodiran antero-ventro-lateral plate, p. 255.

FIGS. 5, 6. Two plates preserved in concretions, $\times \frac{1}{2}$.
Mississippian (Caney shale); Oklahoma.

Series of naturally associated Lepidotid scales, p. 279.

FIG. 7. Specimen, $\times \frac{1}{2}$.
Triassic, Kanab Canyon, Arizona.

PLATE 11.

Ceraspis carinata Schlüter, p. 242.

FIG. 1. Dorsomedian plate, side-view, natural size.

Middle Devonian; Eifel, Germany. Original in Museum of Comparative Zoology, Cambridge, Mass.

Ischyrrhiza mira Leidy, p. 298.

2. Tooth, natural size. Cretaceous; near Dumas, Mississippi.

Coelacanthus elegans Newberry, p. 271.

FIGS. 3, 4. Two distorted examples, $\times \frac{1}{2}$.
Pennsylvanian; Mazon Creek, Illinois.

PLATE 12.

Catopterus gracilis Redfield, p. 280.

FIG. 1. Part of skeleton, including head with scales in place, $\times \frac{1}{2}$.

2. A crushed example, $\times \frac{1}{2}$.
Triassic; Durham, Connecticut.

Semionotus micropterus Newberry, p. 278.

3. Nearly complete specimen, $\times \frac{1}{2}$.
Triassic; Guilford, Connecticut.

Lepidotus walcotti, new species, p. 283.

4. Patch of scale impressions, $\times \frac{1}{2}$.
Triassic portion of Shinarump group; Kanab Valley section, Utah.

Astraspis desiderata Walcott, p. 238.

FIGS. 5, 6. Natural impression of body shield and plaster cast from same, $\times \frac{1}{2}$.
Ordovician (Harding sandstone of Black River); Canon City, Colorado.

PLATE 13.

Catopterus gracilis Redfield, p. 280.

- FIG. 1. Fish on slab of shale, $\times\frac{1}{3}$.
Triassic; Guilford, Connecticut.
2. An incomplete specimen, $\times\frac{1}{3}$.
Triassic; Durham, Connecticut.

Lepidotus walcotti, new species, p. 283.

3. An incomplete individual, $\times\frac{1}{3}$.
Triassic portion of Shinarump group; Kanab Valley section, Utah.

PLATE 14.

Acanthurus, species indeterminate p. 290.

- FIG. 1. Skeleton of young example, $\times\frac{1}{3}$.
Upper Eocene; Monte Bolca, Italy. Original in Museum of Comparative Zoology, Cambridge, Mass.

Belonostomus tenuirostris (Agassiz), p. 286.

2. Young individual, $\times\frac{1}{3}$.
Lithographic limestone, Solenhofen, Bavaria.

Belonorhynchus (?) species, p. 281.

3. Specimen, $\times\frac{1}{3}$.
Upper Triassic; New South Wales.

Notagodus minutus, new species, p. 287.

4. A complete skeleton on slab, $\times\frac{1}{3}$.
Lithographic limestone; Solenhofen, Bavaria.

PLATE 15.

Plioplarchus sczspinosus Cope, p. 295.

- FIG. 1. Complete skeleton on slab, $\times\frac{1}{3}$.
Tertiary (Miocene);
Top of Sentinel Butte, North Dakota.

Notogoneus oculus Cope, p. 289.

2. Skeleton of young individual, $\times\frac{1}{3}$.
Eocene (Green River); Wyoming.

Semionotus elegans Newberry, p. 278.

3. A complete skeleton on slab of sandstone, $\times\frac{1}{3}$.
Triassic; Boonton, New Jersey.

PLATE 16.

Dapedoglossus testis Cope, p. 288.

- FIG. 1. Well-preserved cranium, $\times\frac{1}{3}$.
Eocene (Green River); Wyoming.

Parafundulus nevadensis, new species, p. 291.

2. Nearly complete individual, in white clay matrix, $\times\frac{1}{3}$.
Tertiary (Lahonton beds); near Hazen, Nevada.

Xiphias? species, p. 298.

3. Hypural fan, natural size.
Tertiary (Eocene beds); Coosa River, South Carolina.

PLATE 17.

Parafundulus nevadensis, new species, p. 291.

- A group of specimens, natural size.
Tertiary (Lahonton beds); near Hazen, Nevada.

PLATE 18.

Cladodus aculeatus, new species, p. 255.

- FIG. 1. Teeth.
Mississippian (Caney); Antlers Quadrangle, Oklahoma.

Psephodus legrandensis Branson, p. 259.

2. Naturally associated dental plates of holotype.
Mississippian Kinderhook; Le Grand, Iowa.

Parafundulus nevadensis, new species, p. 291.

3. Drawing of skeleton figured in plate 16, figure 2.
Tertiary (Lahonton beds); near Hazen, Nevada.

Leuciscus (cf. *L. turneri*), p. 292.

4. Skeleton, natural size.
Oligocene or Lower Miocene; Madison Valley, Montana.

Osmerus (?) species, p. 293.

5. Skeleton.
Oligocene or Lower Miocene; Madison Valley, Montana.

PLATE 19.

Amyzon brevipinne Cope, p. 292.

- FIG. 1. Nearly complete skeleton, $\times \frac{1}{2}$.
2. Skeleton lacking head portion, $\times \frac{1}{2}$.
Tertiary (Lower Miocene); near Republic, Washington.

Cyprinodont, p. 293.

3. Example of an undetermined species, $\times \frac{1}{2}$.
Tertiary; Mexico.

PLATE 20.

Ameiurus primaevus, new species, p. 293.

- Nearly complete skeleton of holotype, $\times \frac{1}{2}$.
Eocene (Green River); Wyoming.

PLATE 21.

Mioplosus labracoides Cope, p. 295.

- A large well-preserved specimen, $\times \frac{1}{2}$.
Eocene (Green River); Wyoming.

PLATE 22.

Plioplarchus septemspinosus Cope, p. 295.

One of the type-specimens, $\times \frac{1}{2}$.

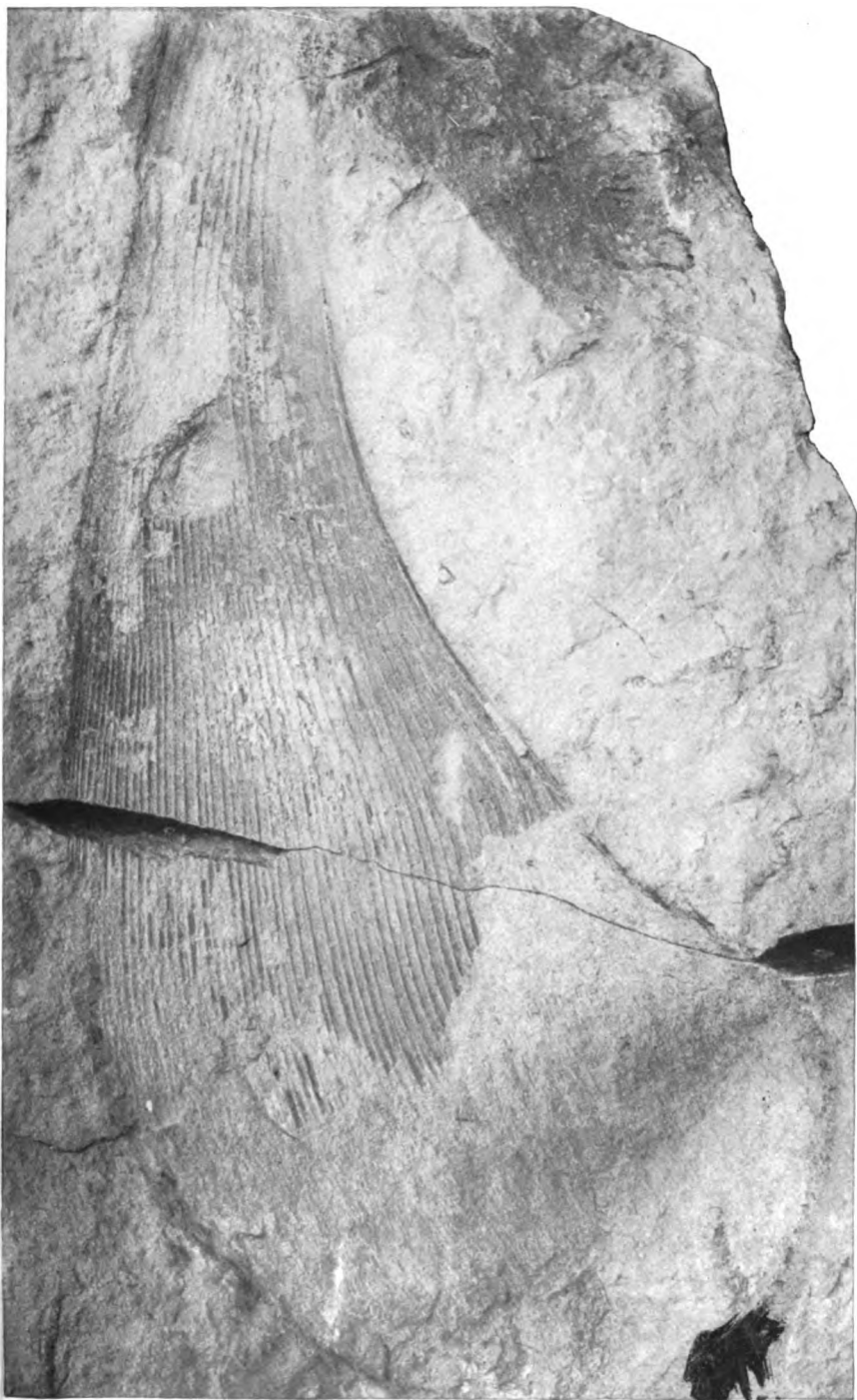
Miocene (?); Van Horn's Ranch, on the John Day River, Oregon.

PLATE 23.

Priscacara dartonae, new species, p. 296.

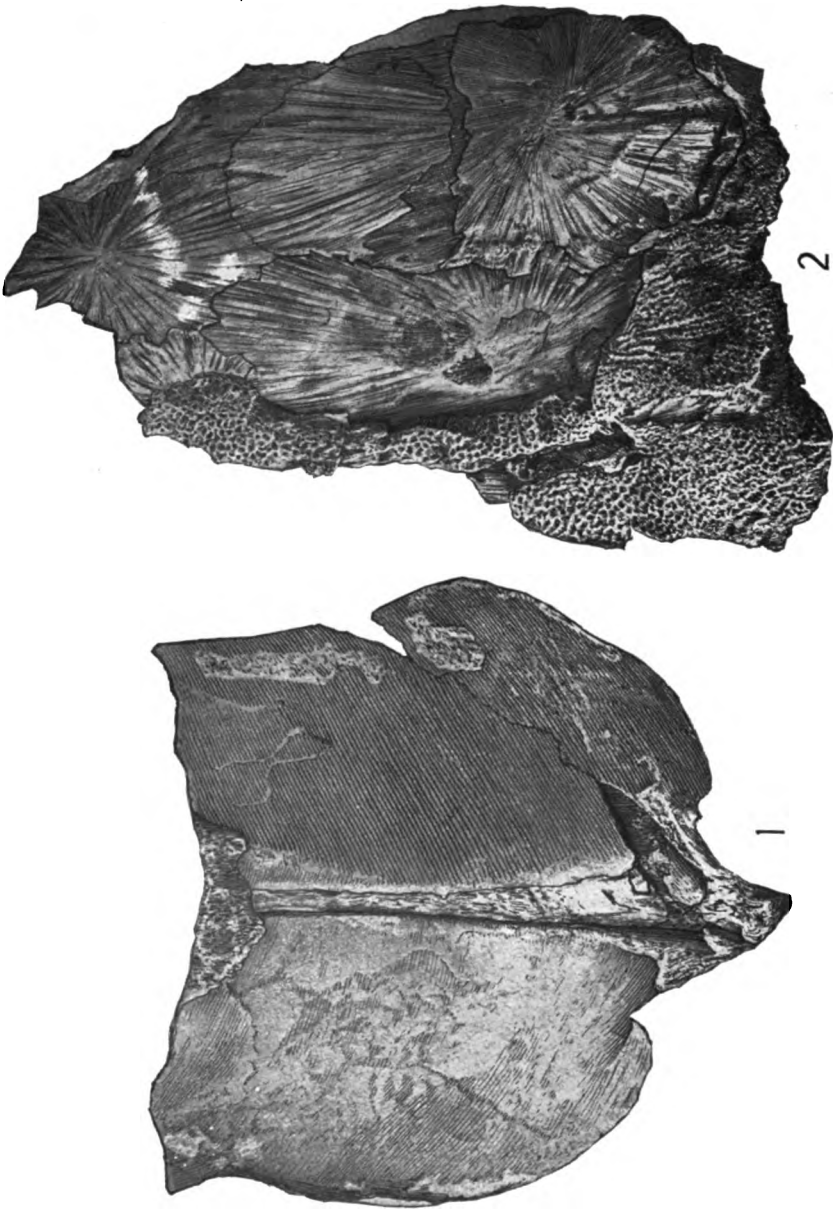
Complete skeleton of the holotype, $\times \frac{1}{2}$.

Eocene (Green River); near Fossil, Wyoming.

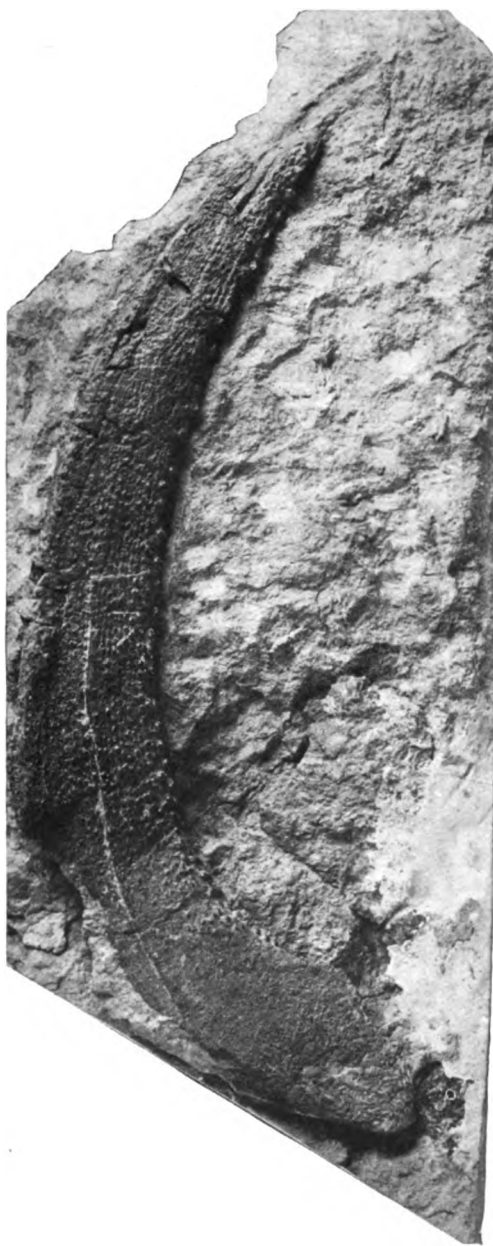


HETERACANTHUS UDDENI.

FOR EXPLANATION OF PLATE SEE PAGE 298.



DINICHTHYS TUBERCULATUS AND SAURIPTERUS TAYLORI.
FOR EXPLANATION OF PLATE SEE PAGE 298.



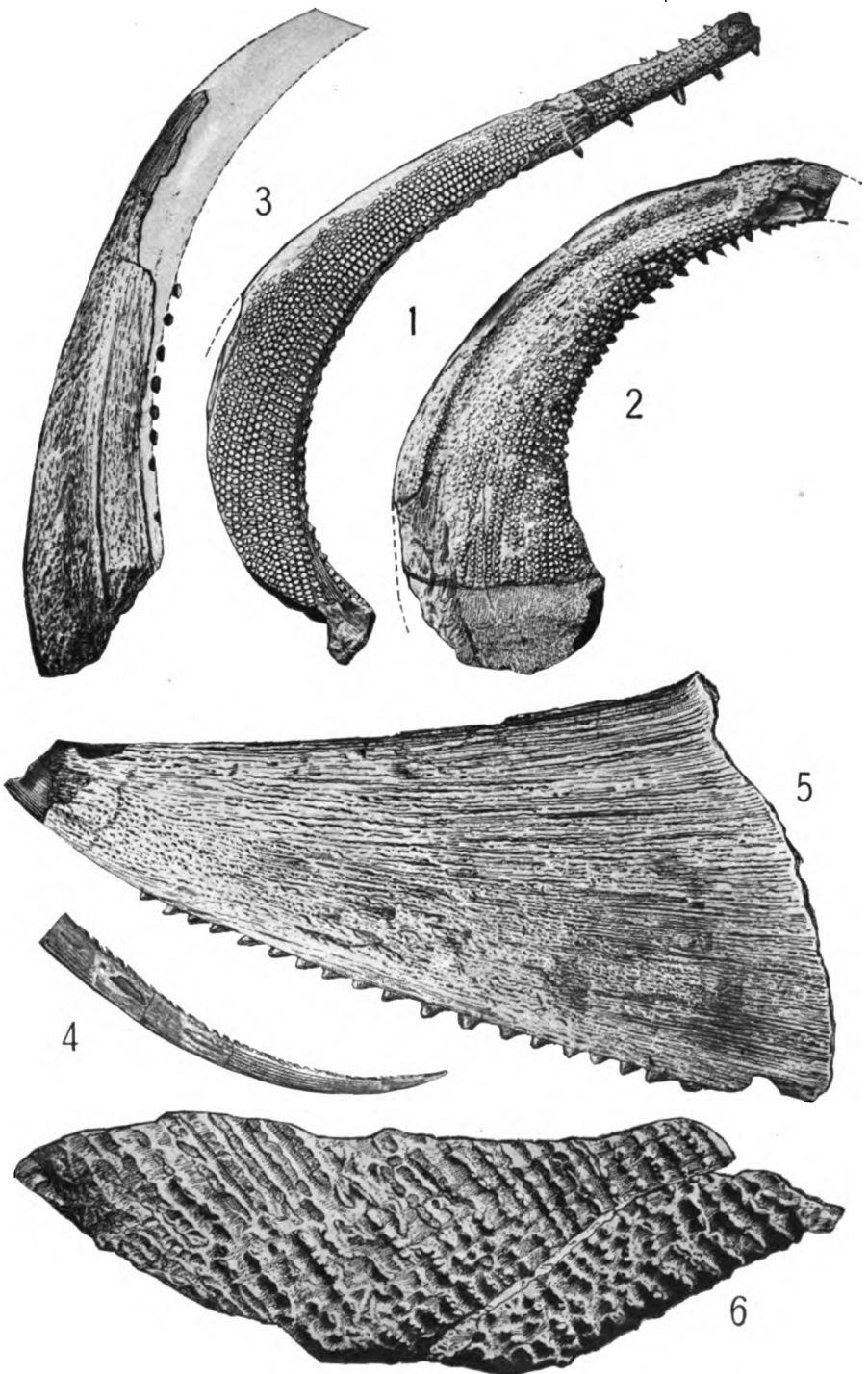
PHYSONEMUS GEMMATUS.

FOR EXPLANATION OF PLATE SEE PAGE 298.



PHYSONEMUS GEMMATUS.

FOR EXPLANATION OF PLATE SEE PAGE 298.



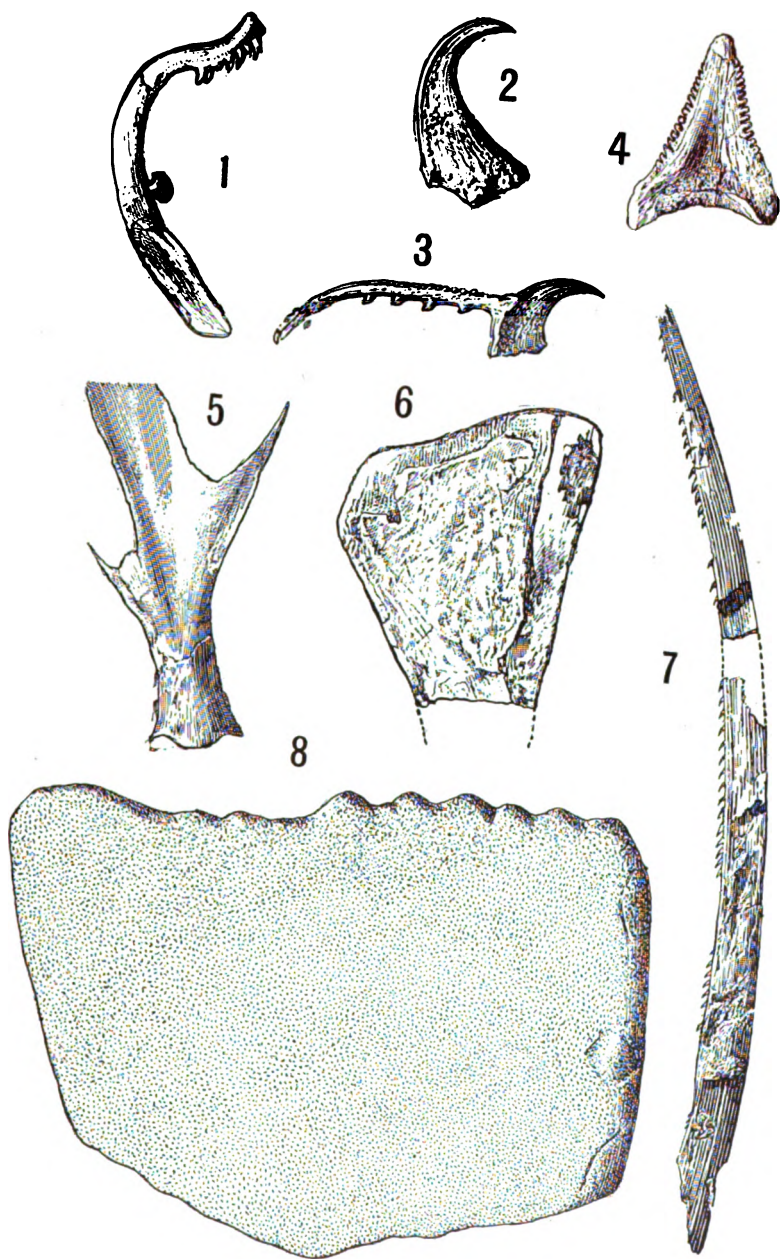
PHYSONEMUS ARCUATUS, P. GEMMATUS, CTENACANTHUS GRACILLIMUS, AND ORACANTHUS TRIANGULARIS.

FOR EXPLANATION OF PLATE SEE PAGES 298 AND 299.



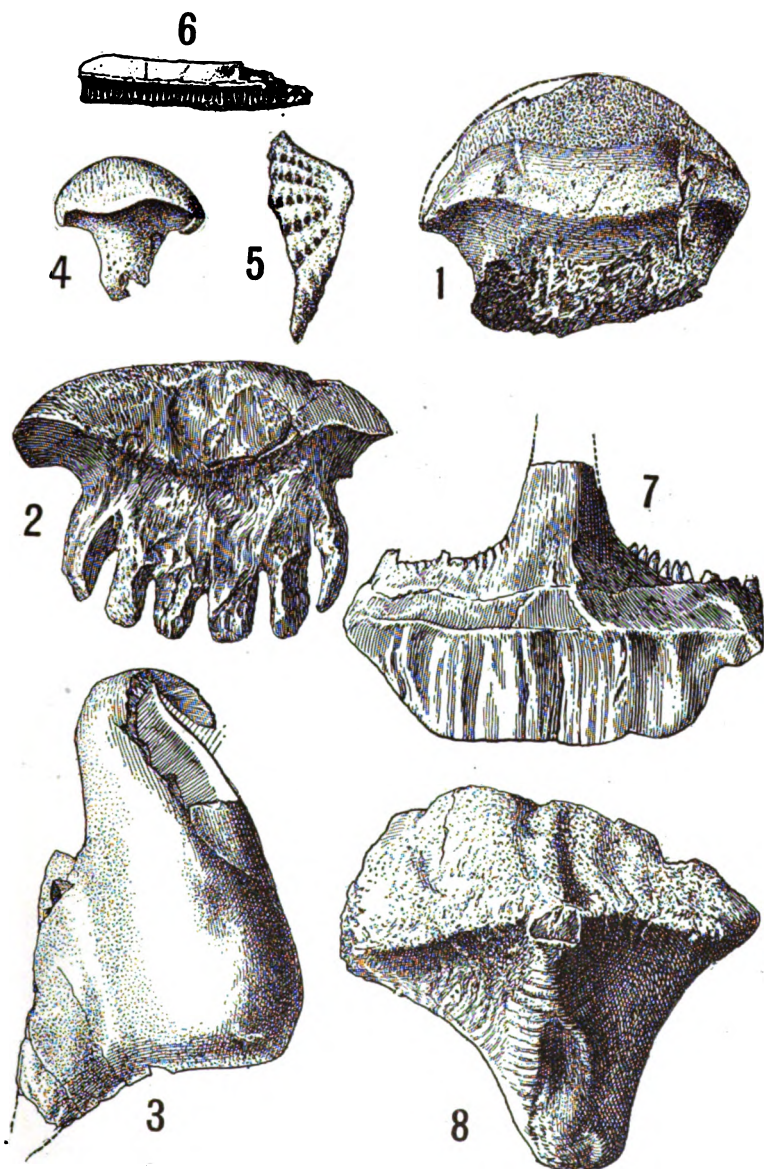
EDESTUS HEINRICHI AND ORACANTHUS VETUSTUS.

FOR EXPLANATION OF PLATE SEE PAGE 299.



HARPACANTHUS PROCUMBENS, ERISMACANTHUS MACCOYANUS, DICRENODUS TEXANUS, SAURIPTERUS TAYLORI, COCCOSTEUS, SPECIES, CTENACANTHUS GRACILLIMUS, AND PSAMMODUS PLENIS.

FOR EXPLANATION OF PLATE SEE PAGE 299.



POLYRHIZODUS GRANDIS, DELTODUS OCCIDENTALIS, POLYRHIZODUS CONCAVUS, DIP-
TERUS ANGUSTUS, POLYRHIZODUS GRANDIS, CHOMATODUS, SPECIES, CLADODUS
SPINOSUS, AND DINICHTHYS PUSTULOSUS.

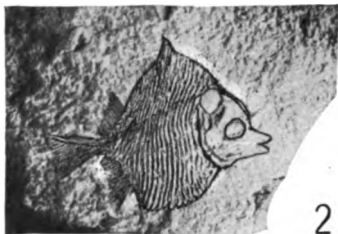
FOR EXPLANATION OF PLATE SEE PAGES 299 AND 300.



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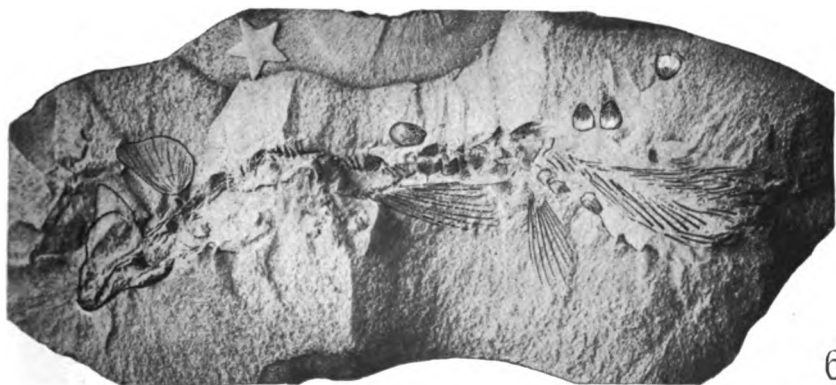
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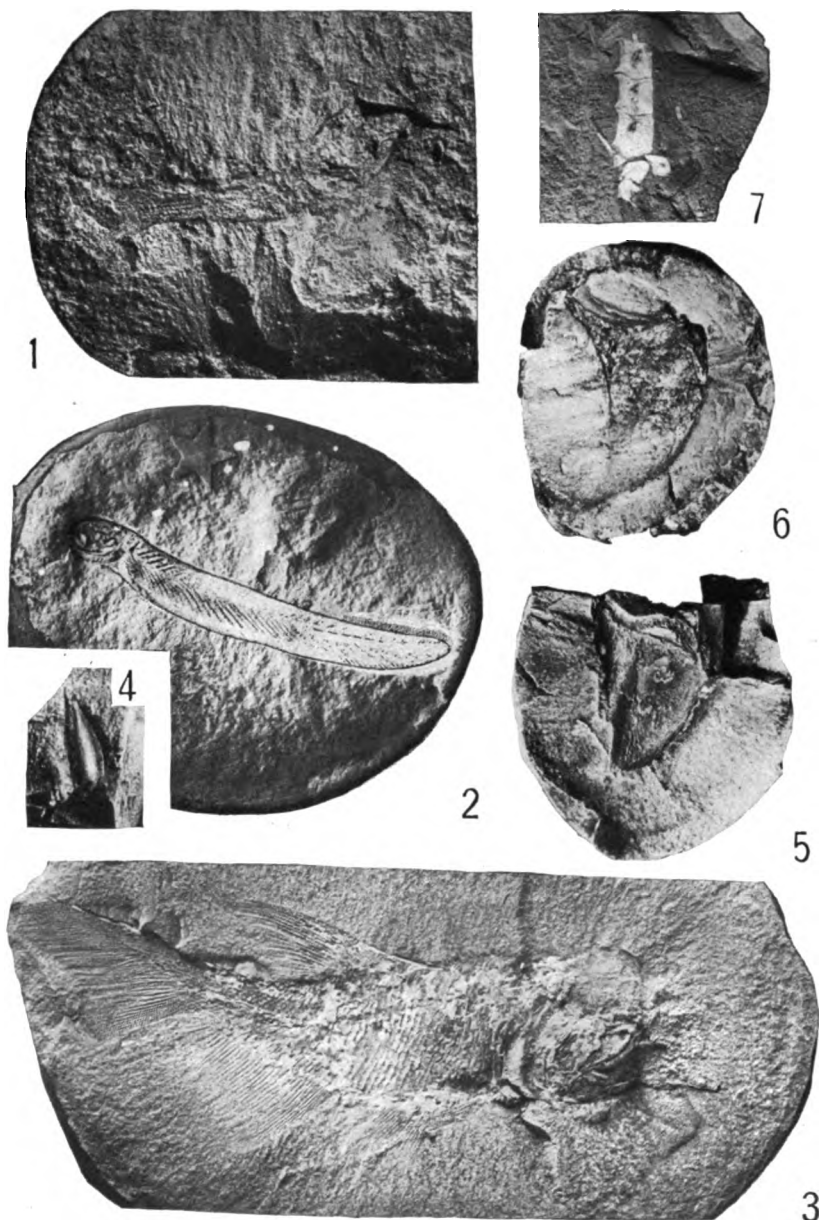
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6

**ELONICHTHYS PERPENNATUS, CHEIRODUS ORBICULARIS, ELONICHTHYS HYPSPLEPIS,
RHADINICHTHYS GRACILIS, AND COELACANTHUS ELEGANS.**

FOR EXPLANATION OF PLATE SEE PAGE 300.

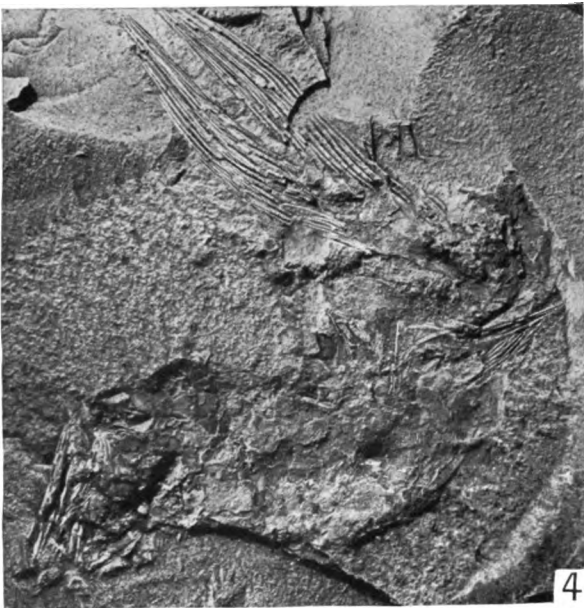


COELACANTHUS EXIGUUS, PALAEOPHICHTHYS PARVULUS, ELONICHTHYS HYPHILEPS,
CLADODUS ACULEATUS, ARTHRODIRAN PLATES, AND LEPIDOTID SCALES.

FOR EXPLANATION OF PLATE SEE PAGES 300 AND 301.



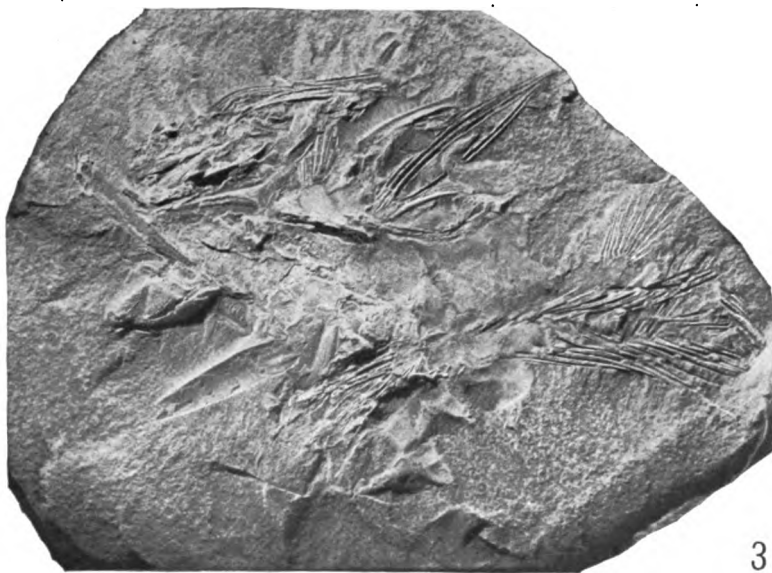
1



4



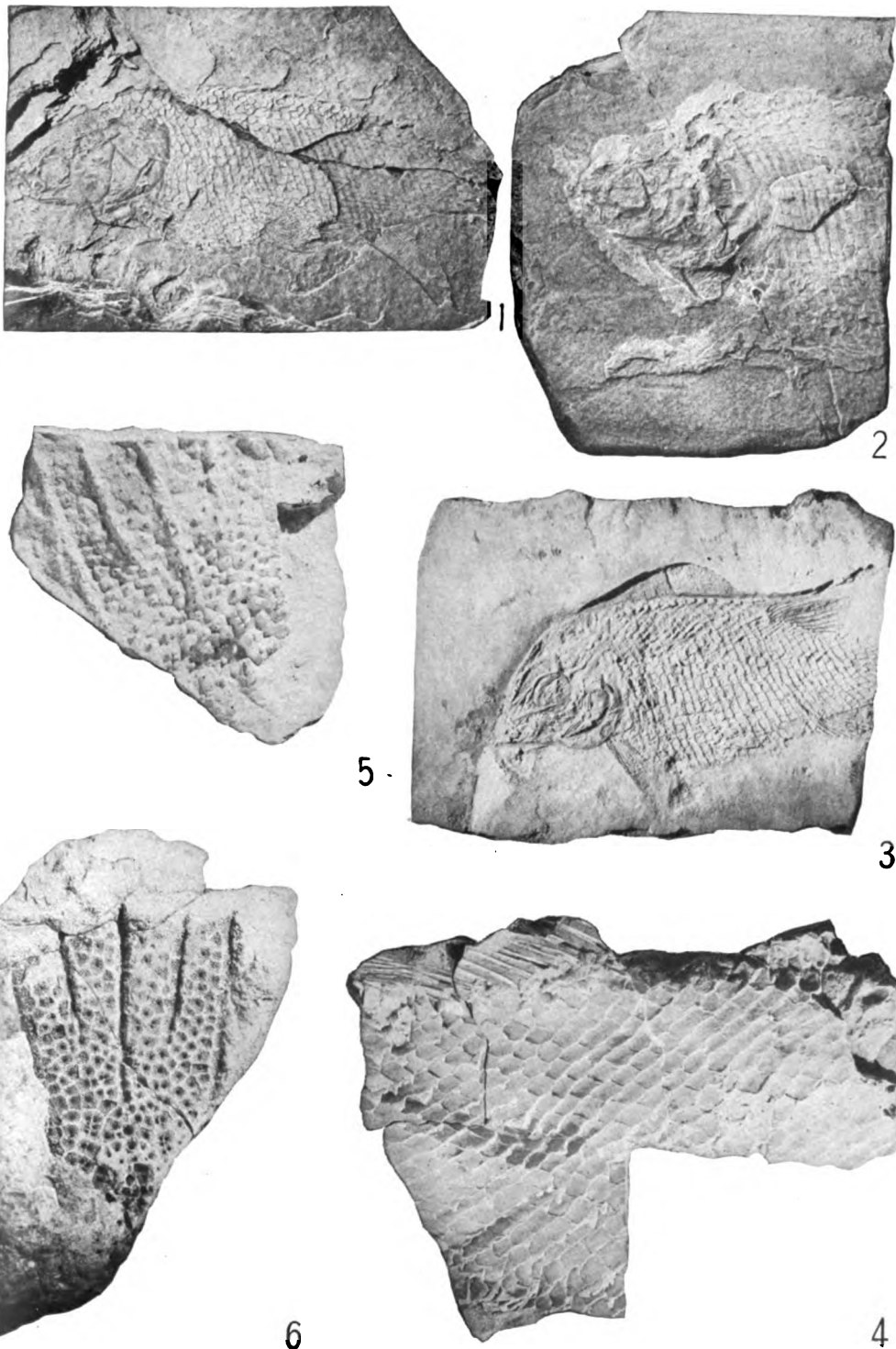
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3

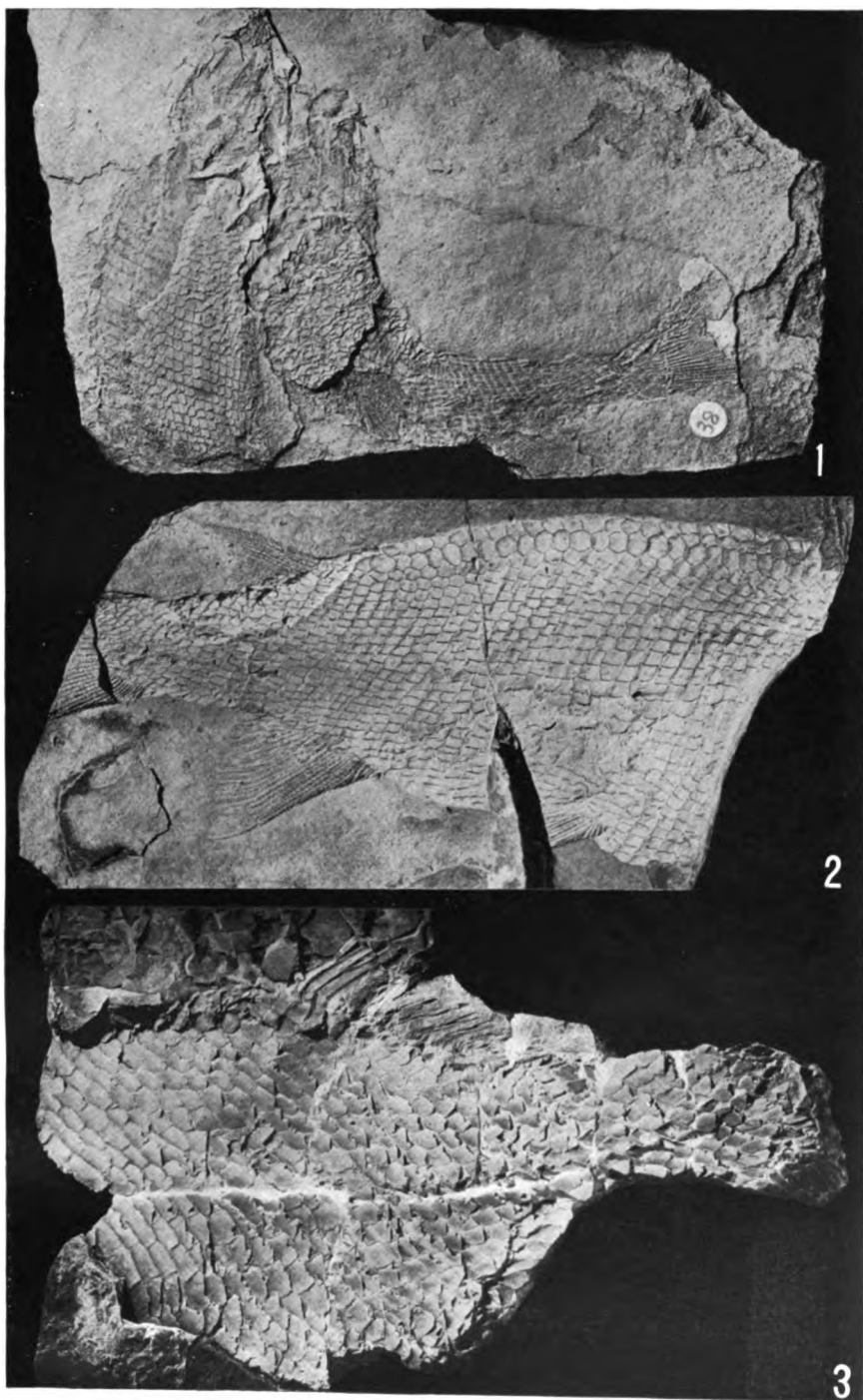
CERASPIS CARINATA, ISCHYRIZA MIRA, AND COELACANTHUS ELEGANS.

FOR EXPLANATION OF PLATE SEE PAGE 301.



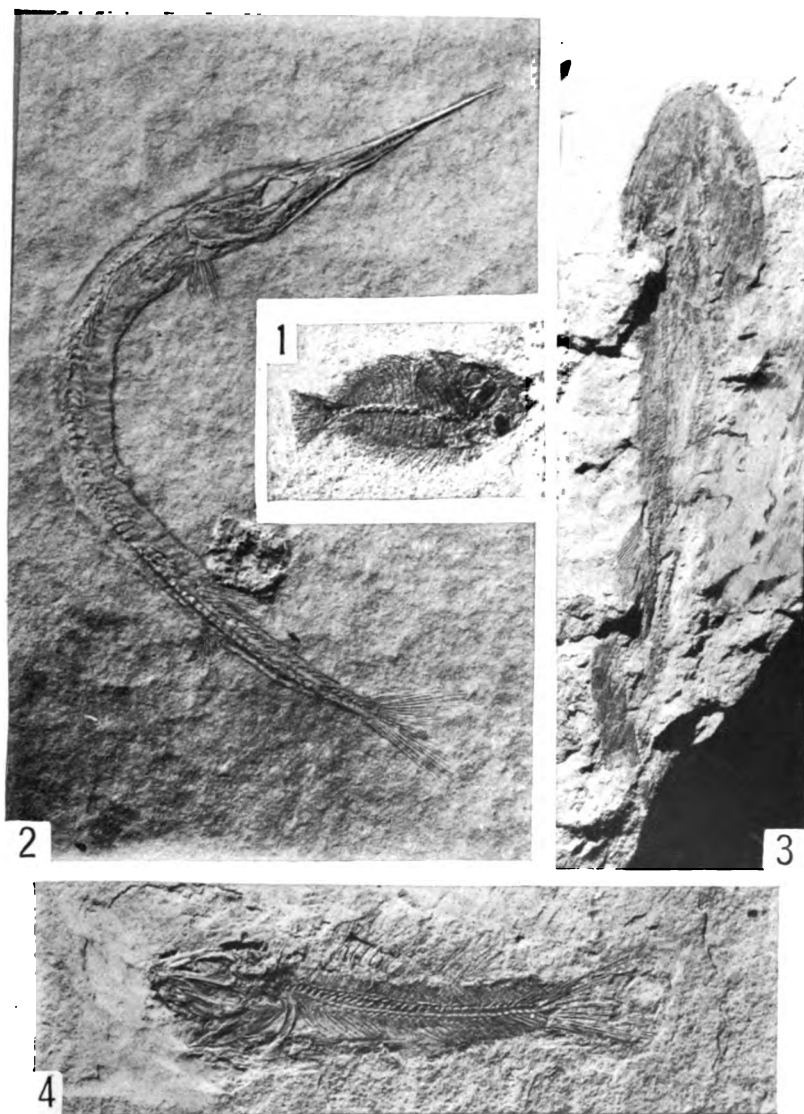
CATOPTERUS GRACILIS, SEMIONOTUS MICROPTERUS, LEPIDOTUS WALCOTTI, AND ASTRASPIS DESIDERATA.

FOR EXPLANATION OF PLATE SEE PAGE 301.



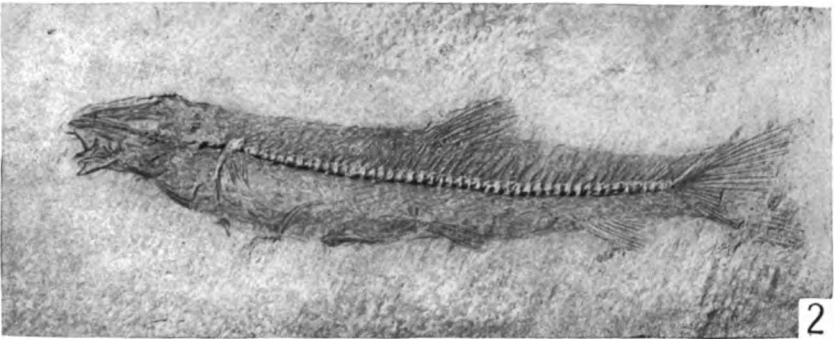
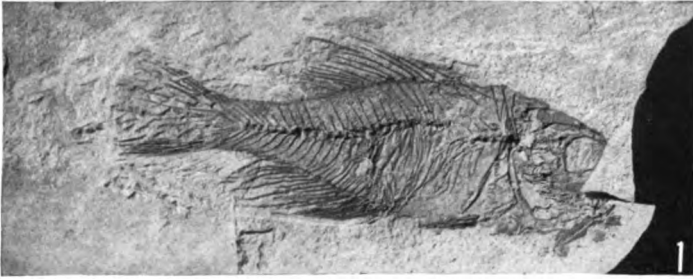
CATOPTERUS GRACILIS, AND *LEPIDOTUS WALCOTTI*.

FOR EXPLANATION OF PLATE SEE PAGE 302.



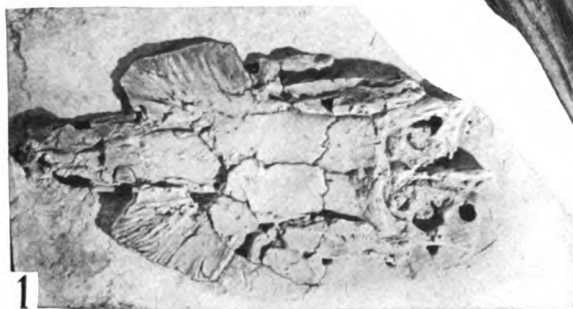
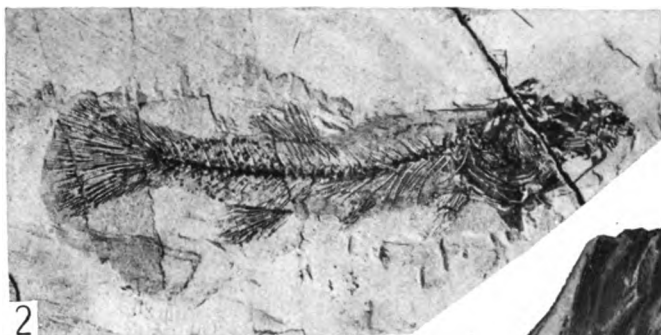
ACANTHURUS, SPECIES, BELONOSTOMUS TENUIROSTRIS, BELONORHYNCHUS (?) SPECIES,
AND NOTAGOGUS MINUTUS.

FOR EXPLANATION OF PLATE SEE PAGE 302.



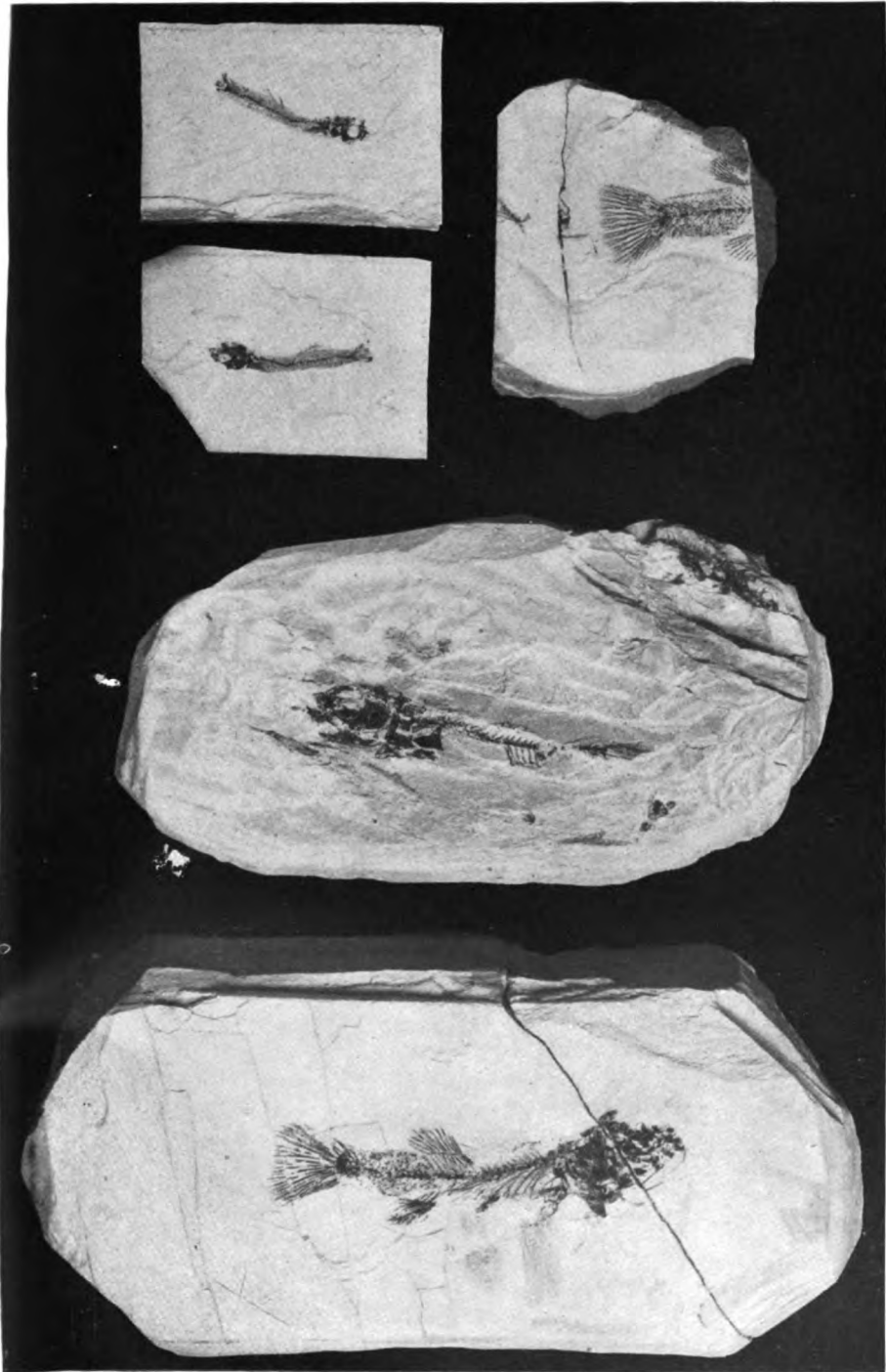
PLIOLARCHUS SEXSPINOSUS, NOTOGONEUS OSCULUS, AND SEMIONOTUS ELEGANS.

FOR EXPLANATION OF PLATE SEE PAGE 302.



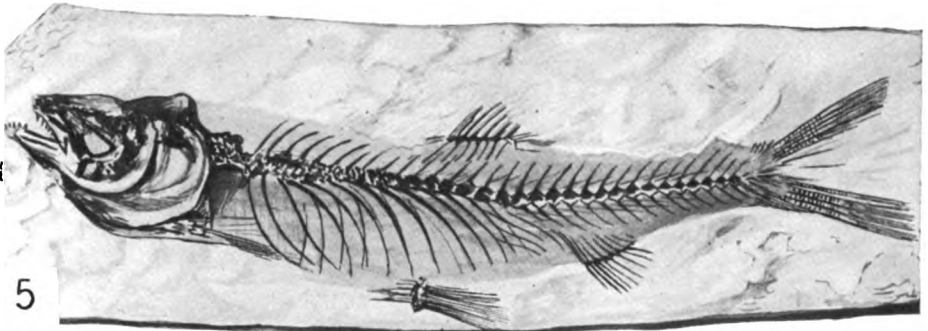
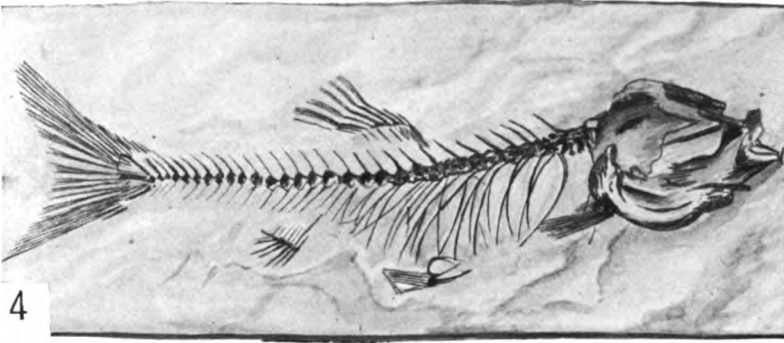
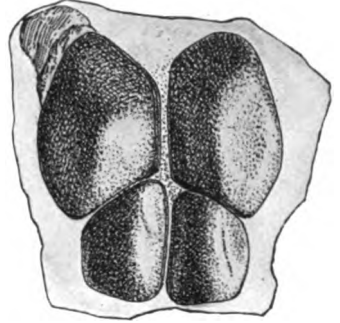
DAPEDOGLOSSUS TESTIS, PARAFUNDULUS NEVADENSIS, AND XIPHIAS?, SPECIES.

FOR EXPLANATION OF PLATE SEE PAGES 302 AND 303.



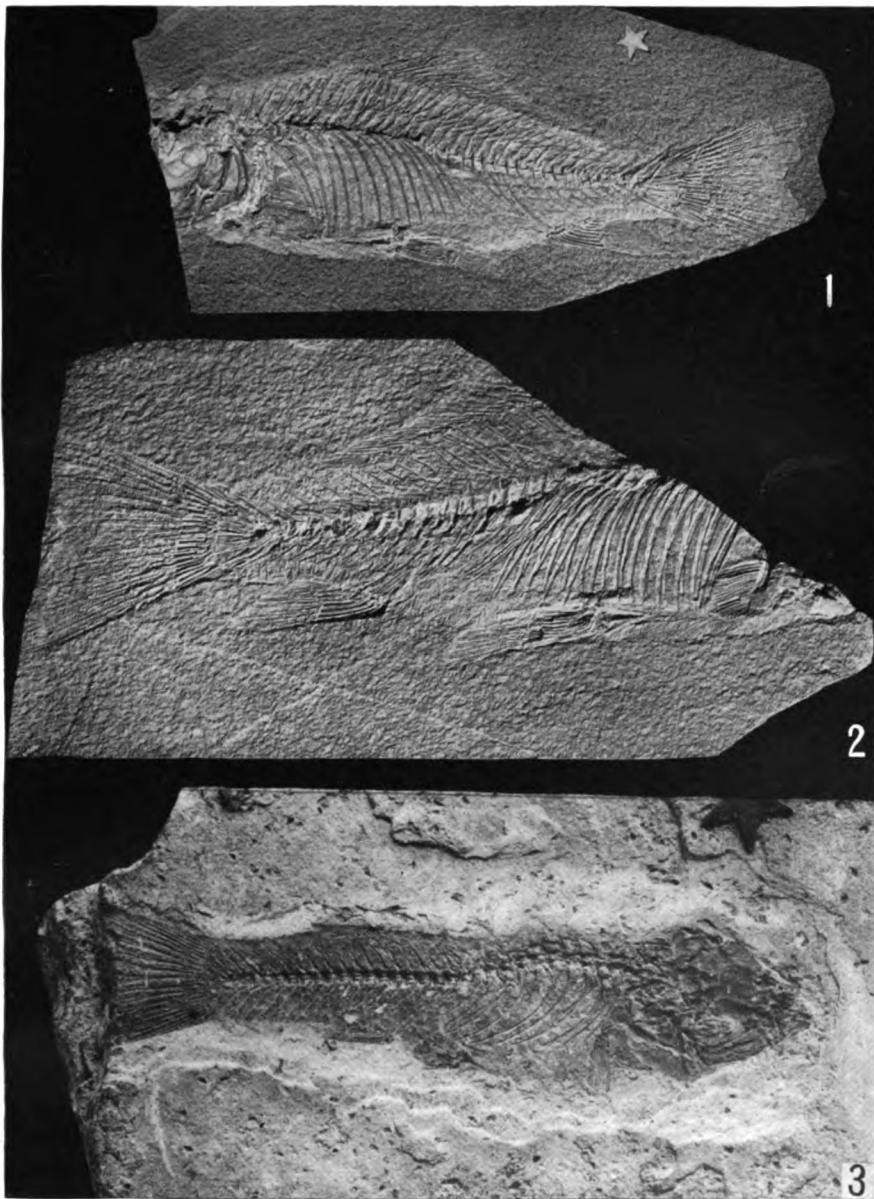
PARAFUNDULUS NEVADENSIS.

FOR EXPLANATION OF PLATE SEE PAGE 303.



CLADODUS ACULEATUS, PSEPHODUS LEGRANDENSIS, PARAFUNDULUS NEVADENSIS, LEUCISCUS,
AND OSMERUS (?) SPECIES.

FOR EXPLANATION OF PLATE SEE PAGE 303.



AMYZON BREVIPINNE, AND CYPRINODONT.

FOR EXPLANATION OF PLATE SEE PAGE 303.



AMEIURUS PRIMAEVUS.

FOR EXPLANATION OF PLATE SEE PAGE 303.

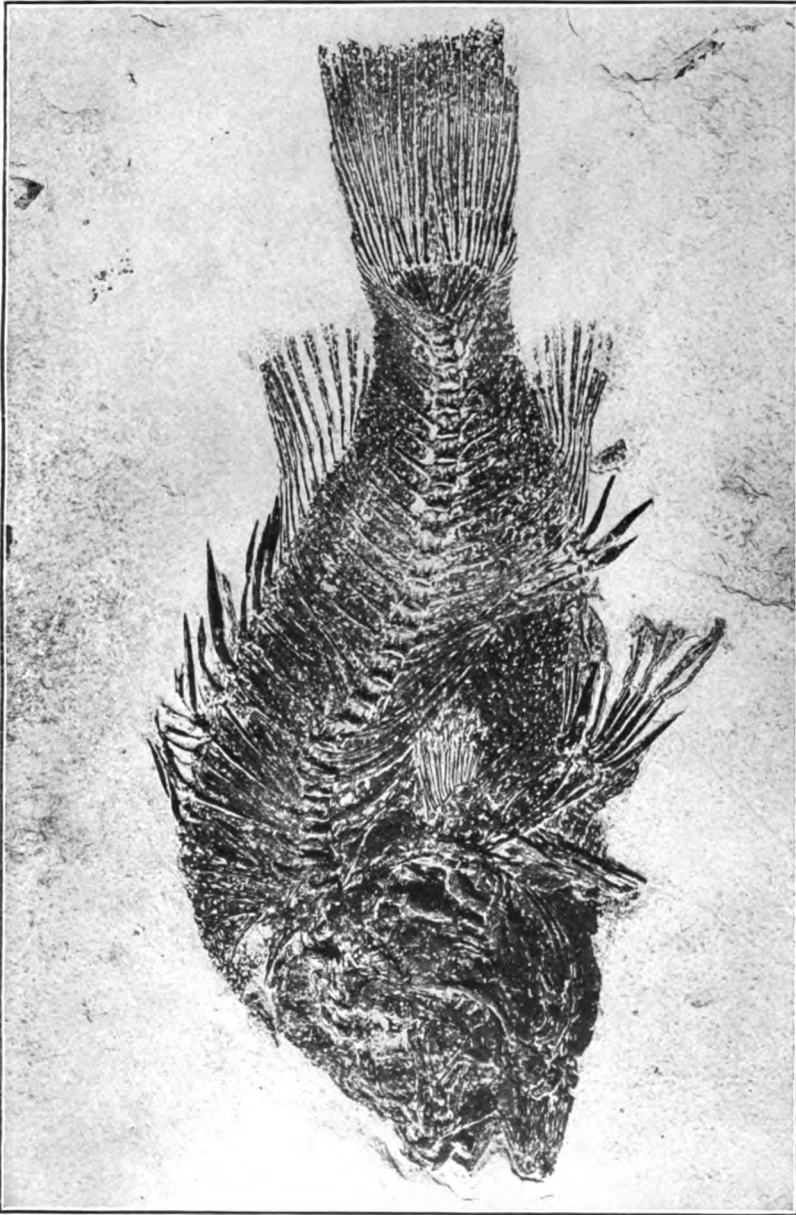


MIOPLOSUS LABRACOIDES.
FOR EXPLANATION OF PLATE SEE PAGE 303.



PLIOPLARCHUS SEPTemspINOSUS.

FOR EXPLANATION OF PLATE SEE PAGE 304.



PRISCACARA DARTONAE.
FOR EXPLANATION OF PLATE SEE PAGE 304.

MONOGRAPH OF THE NEARCTIC HYMENOPTERA OF THE GENUS *BRACON* FABRICIUS.

By HAROLD MORRISON,
Of the Federal Horticultural Board, Washington, D. C.

INTRODUCTION.

The following paper gives the results of a portion of the work done on a collection of insects of the subfamily Agathinae of the family Braconidae. Under the existing circumstances it has not been found possible to go over the whole of the collection, nor to put into completed form more than the monographic classification of this one genus. The collection from which specimens were examined was obtained from the following sources, mostly through the kindness of Prof. J. C. Bradley of Cornell University, under whose direction the work was started; the greatest number came from the United States National Museum, about 1,000 specimens belonging to this subfamily being obtained there; the next largest collection came from the Academy of Natural Sciences at Philadelphia, but unfortunately none of these have been available for final examination. In addition, specimens were obtained from the Cornell University collection, the American Museum of Natural History, Prof. C. T. Brues of Bussey Institution, Mr. C. W. Johnson of the Boston Society of Natural History, Mr. W. M. Mann of Bussey Institution, and Mr. Nathan Banks.

In addition to expressing my appreciation of the kindness of the United States National Museum authorities in charge of the insect collections and of the above-mentioned gentlemen, I also wish to thank Professor Bradley for many suggestions during the early part of the work which was started at Cornell University, Dr. Henry Skinner for permission to examine the Cresson types in the Academy of Natural Sciences in Philadelphia, and Prof. V. L. Kellogg for many ideas regarding the basis upon which species limits should be determined. The drawings accompanying the paper were made by Mr. C. H. Kennedy. Most of the work was done in the entomological laboratory of Stanford University.

SUBFAMILY AGATHINAE.

The following characters, taken from the papers of Szepligeti and Ashmead, will show what forms are to be included here: Abdomen inserted at the apex of the propodeum between the hind coxae; mandibles, when closed, with their tips touching or crossing, not forming a rounded opening in conjunction with a semicircularly emarginate clypeus; abdomen subsessile, the dorsum showing the usual sutures, except between the second and third tergites; radial cell very narrow, and not approaching the tip of the wing, the second cubital cell (areola) very small, or wanting in some cases; eyes not hairy. The very small or missing second cubital cell, and the narrow radial cell, with the radial vein running parallel or almost parallel to the margin of the stigma, are the most easily recognized and most distinctive characters. In the older classifications, best presented by that of Marshall, this subfamily was included with the Microgasterinae in the group Areolarini of Wesmael, but the last two general classifications, that of Ashmead (1900) and Szepligeti (1904), present the subfamilies without attempting to group them in higher units.

Twenty-five known genera are recognized by Szepligeti, while he gives five additional, which contain no described species or are not recognizable. Since the publication of his paper some five or six new genera have been described, while of this number, 10 genera have been reported or described from the United States. Species belonging in the subfamily have been recorded from all of the larger land areas of the earth, and from some islands, as Hawaii and the Philippines. At present a majority of the known species are from the Palearctic and Nearctic regions, but it seems probable that a more thorough collection throughout the world will show that the species are most abundant in tropical regions.

It is obvious, even from the limited study which I have made of the different species included in this subfamily, that a revision of the genera is greatly needed. The one character to which most importance has been attached since the beginning of attempts at classification, the shape and appearance of the head when viewed from in front, is easily shown to be of little or no value generically, if any considerable series of species is examined, although it seems to be useful for specific determination, and is somewhat characteristic in certain genera. However, it is impossible to draw any distinguishing line, based on this character, between the genera *Agathis* and *Bassus* (*Microdus*), as they are at present recognized in this country, although Förster, followed by Ashmead in his classification of the Ichneumon Flies, divided the subfamily into two tribes, the *Agathidini*, with the head as viewed from in front shaped as an elongate isoceles triangle, and the *Microdini*, with the head short and forming an equilateral

triangle. The more recent classifications, particularly that of Szepligeti, make no attempt to group the genera into units of higher rank.

It is necessary to discuss a recent change in synonymy, given by Viereck in his paper on the Type Species of the Genera of Ichneumon Flies,¹ in order to make clear the use of a certain generic name which has long been associated with another group of parasitic Hymenoptera. This change of name is taken from Viereck's paper referred to above, as I have not had access to Curtis's British Entomology to verify Viereck's conclusions.

Fabricius described the genus *Bracon* in his *Systema Piezatorum* in 1804, page 102, with a number of included species. Curtis in his *British Entomology* (1825), No. 69, designated the species described as *Ichneumon desertor* by Linnæus, and included in *Bracon* by Fabricius, as the type of the genus *Bracon*. Not until 1862 did Förster² designate *Bracon minutator* Fabricius as the type of *Bracon*, and so establish the present-day conception of the genus. In the same paper (p. 246) Förster established the new genus *Cremnops* and included the single species *Agathis deflagrator* Nees, which is the same species as *Ichneumon desertor* Linnæus. From this it is clear that the genus name *Bracon* will have to be applied to those species at present included in the genus *Cremnops*, and that *Cremnops* Förster is a synonym of *Bracon* Fabricius. It is extremely unfortunate that taxonomic work on the parasitic hymenoptera should be still further complicated in this fashion, but there seems to be no other alternative if the International Code of Nomenclature is followed.

GENUS *BRACON* FABRICIUS (*CREMNOPS* FÖRSTER AND OF AUTHORS).

The following characters, not all of which, however, are distinctive, will serve to indicate the species belonging to this genus:

Head elongate, at least nearly as long as wide, strongly produced below the eyes, and much narrowed towards the labrum; malar space varying from a little shorter to a little longer than the height of the eyes; antennae placed in large pits, with two distinct, more or less platelike projections between them, and with a ridge bordering the upper surface of each pit, at least for part of the distance between the compound eyes and the lateral ocellus on each side; ocelli arranged in a nearly equilateral triangle; antennae elongate, black, except in immature specimens, more than 35-segmented; labrum at least nearly as long as wide, its lower edge margined by a more or less distinct ridge; mandibles curved inwards, the tips bidentate, the inner tooth shorter than the outer; maxillae and labium united and elongated to form a distinct beak, the segments of both maxillary and labial

¹ U. S. Nat. Mus. Bull. 83, 1914.

² Verh. naturh. ver. preuss. Rheinland, vol. 19, 1862, p. 235.

palpi elongate; apex of the pronotum with large deep pits on each side of the middle line, these united in one species; mesonotum with well-developed parapsidal furrows, these often crenulate, at least in the middle, the median lobe distinctly grooved longitudinally, the lateral lobes more or less flattened; hind angles of the mesoscutum usually produced into a vertically compressed plate, fingerlike in one species; mesopleural furrow present, varying in size and shape; propodeum coarsely areolate, with three longitudinal ridges on each side; spiracles of the propodeum oval; wings fuliginous, the second cubital cell (areolet) four-sided, never triangular; legs long, rather slender, middle tibiae usually, hind tibiae always, with one or more spines at the apex; at least the fore, usually the intermediate, and often the hind tarsal claws cleft, if not cleft then broad and long-toothed at the base; abdomen elongate, first segment long and usually slender; ovipositor in general about as long as the abdomen, sometimes a little shorter; colors, black, and various shades of red, running to yellow.

The genus as defined above includes 12 recognizable species from America north of the Mexican border, of which number only one was originally described as belonging in the genus, while two have been transferred from the genus *Agathis*, and nine are described as new. The specimens available for examination show that the species are widely distributed over the whole of the United States, and it seems probable that only lack of collections is responsible for the meager Canadian records.

EXTERNAL ANATOMY.

The following rather brief account of the external anatomy, based largely on a study of *B. vulgaris*, will make clear some of the structural characteristics not fully discussed in the specific descriptions:

Head.—The head is hypognathous, transverse, and strongly produced below the eyes, usually longer from the apex of the clypeus to the top of the lateral ocelli than the extreme width through the compound eyes. The compound eyes are of medium size, varying from a little longer to a little shorter than the malar space, oval in shape, with the back side flattened, as viewed from the side, semicircular in outline with the inner side somewhat curved as viewed from above, and half oval with the inner side slightly curved as viewed from in front. They approach most closely to each other at a point a little below the antennal pits. The upper portion of the vertex is rounded into the occiput behind and the face in front, except in the middle, where it is strongly excavated on each side to form two pits for the reception of the antennae. The lateral ocelli are placed on the apex of the vertex, usually a little closer to each other than to the margins of the compound eyes, and from them each antennal pit slopes

steeply, almost vertically downwards to the insertion of the antenna. Between the antennal insertions are a pair of triangular or almost platelike projections, separated along the median line by a triangular or rounded groove, and with their front edges in the same plane as the face, rounded off at the apex, and extending backwards between the antennae as a pair of small ridges which may reach the lower edge of the median ocellus. This median ocellus is placed on the sloping surface of the vertex, and approximately as far from the lateral ocelli as they are from each other. The median ocellus is circular in outline, while the two lateral ocelli have the inner front margins somewhat flattened. All of the ocelli are placed on slight elevations, and the vertex is more or less swollen between the lateral ocelli, the elevation in some cases approaching the appearance of an obsolete, very short, longitudinal ridge. A more or less distinct marginal ridge runs along the lower border of each antennal pit to where this border turns upwards parallel to the eye margin, while from here on, at least, the ridge is distinct and nearly always swells into a low arch which is most prominent opposite some point on the median ocellus, as the lower margin, the upper margin, or the middle. From the highest point the ridge decreases in height gradually until it reaches the lateral ocellus on its side, or in some cases until it becomes obsolete some distance from the lateral ocellus. The head tapers rapidly behind the eyes, and the occiput is strongly emarginated.

In all normal specimens the whole of the vertex, the occiput, and the head behind the eyes, and usually the cheeks are shining and often appear polished, while the punctuation, and with it the hairiness, varies from quite dense to wholly lacking over the various parts mentioned. Usually there is a distinct fringe of hairs, most noticeable in front and below, surrounding the compound eyes. The face proper extends from the antennal fossae to the clypeal foveae, two small deep pits located diagonally below and inside the lower corner of each eye. Even cleared specimens show no transverse suture separating the face from the clypeus, and for purposes of description I have taken the face as extending from the antennal pits to the tip of the clypeus. The face is nearly always triangularly flattened below the antennae, the flattened area starting near the outer lower angle of each fossa, and coming to a point on the median line of the face not far below the interantennal plates. A more or less distinct groove runs from between the interantennal plates to the lower end of this flattened area. The largest and most closely placed punctures found on the head are located on this flattened surface and on the face on each side of it. Nearer the sides the punctures become smaller until the malar space and at least the lower portion of the clypeus are rather finely punctate. From each clypeal fovea a suture, superficially often wholly obsolete, runs to the lower corner of the head on

each side. The head bulges more or less behind the eyes, depending on the species, and the whole hinder surface is cut out for about the lower two-thirds of its length for the attachment to the thorax, and principally for the reception of the elongated beak, which roughly resembles that found in the long-tongued bees.

The antennae are elongate, longer than the head and thorax, slender, black in all maturely colored specimens, thickest at about the fifth to seventh segments, tapering apically to a point. The number of segments found in the antennae varies from 35 to 45. The first segment or scape (these two terms being used indiscriminately in the specific descriptions) is small at its base, but much swollen above and somewhat flattened, with the apical margin usually rounded but produced into a small blunt tooth in one species. The second segment is small and about the same diameter as the flagellum. Both of these segments are smooth and shining and sparsely punctured and hairy. The remaining segments of the flagellum are cylindrical, slightly constricted in their middle, dull, distinctly striate longitudinally, and closely covered with short, stout, decumbent hairs. The terminal segment is oval in shape with the apex pointed, sometimes indistinctly separated from the preceding segment, and the terminal segments show a more decided intersegmental constriction than do the basal ones.

The labrum is attached to the lower end of the clypeus in such a way that it is slightly less prominent than the face. It is straight in profile, but strongly arched transversely, and varies from distinctly narrower than long to slightly wider than long. Typically the whole outline is curved from the narrow attachment at the top to the tip. Sometimes the apical margin is nearly straight for a short distance on each side of the middle line, while in one species the sides appear to be nearly straight for a little way, and usually the margins from the rounded lateral sides to the attachment to the clypeus are straight or almost straight. The lower border is more or less raised to form a low marginal ridge which fades out on the sides. The whole surface of the labrum is shining and usually smooth, although in many cases the punctures are large enough to break up the smooth appearance. The punctuation, and with it the hairiness, is sparse, but the hairs are relatively long. The coloration is variable, although usually the same as that of the face. The mandibles are strongly curved inward near the apex, sharp pointed, and with a large tooth inside near the tip. They are triangular in section near the middle, with the outer side slightly rounded off and the base enlarged, while compared with other members of the subfamily they are relatively narrow. Usually they are pale except for the extreme tips, but in some species they are wholly dark.

The beak is made up of the two maxillae and the labium, which are united to each other by membranes. All of the parts are elongated, particularly the sclerites of the maxillae. The relative thickness and length of the maxillary and labial palpi vary in the different species, but not greatly enough to be of value for identification. An idea of the general appearance of the beak may be obtained from plate 25, figures 4 and 5. With the possible exception of the labrum, none of the mouth parts appear to show any variations large enough to be considered as of use in distinguishing species.

Thorax.—The thorax is somewhat longer than high, compressed, and about as wide as the head. The pronotum is very narrow in front and widens out on each side into a triangular lobe reaching back to the tegula and downwards to the insertion of the fore coxae. Typically there is a pair of small oval pits, each tapering to a point below and surrounded by a more or less distinct ridge, which continues downward to the front margin of the lobe, on each side of the median line and separated from each other by a distance about equal to the length of one pit. These pits are deepest at the top and gradually become shallower and narrower below, while they are connected by a more or less distinct suture which is either curved or obtusely angled toward the cephalic margin of the pronotum on the median line. In one species these apical pits are replaced by a large deep transverse groove. The hinder, lower, and front margins of the pronotal lobes are elevated to form a narrow ridge running from the spiracle below the tegula on one side around to that on the other. The front margin of each lobe is interrupted a little above its middle by the intrusion of the carina from the pronotal pit, this ridge being much more prominent than the one bordering the lobes. The face of each lobe is depressed along a straight line running from the apical pits to the lower corner of the lobe in such a way that the whole hinder portion of the lobe forms one face of the very flat groove and the cephalic border flares sharply to form the other face, this depression being for the reception of the fore femora. A shallow crenulate groove parallels the hind border, separating a narrow strip from the main portion of the lobe.

The dorsal surface of the pronotum is punctured as is the front border of each lobe, while most of the central portion is smooth and not punctured, although this varies according to the species. There is a band of fine punctures along the upper border, while the narrow strip behind the crenulate groove is closely and densely punctured, as is the lower angle of each lobe. The epimera of the prothorax are completely hidden by the pronotal lobes, and they are separated from the proepisternum of each side by a sharp ridge which lies against and fits closely to the marginal ridges of the pronotal lobes. The episterna are elongate narrow lobes, apparently united

above just below the attachment of the head, then distinctly but very narrowly separated and once more apparently united before they attach to the small prosternum which is a depressed triangular piece seemingly wedged in between the apices of the two episternal lobes. The surface of the prosternal lobes usually appears to be rather closely covered with long, somewhat decumbent hairs, all directed downward, sometimes giving a silvery appearance. A close examination of the surface of the lobes shows that the punctures in which these hairs are inserted are large enough to break up its smoothness and to give it a roughened appearance, although the extent of this appearance varies with the species and even within the species. In all of the species examined the large lobes end in smooth, highly polished and, at most, finely punctate areas, which flare out laterally to meet the tips of the pronotal lobes.

The mesonotum is elongate, strongly narrowed in front, and much higher than the pronotum. In all of the members of the genus the parapsidal furrows are well developed, and in many of them they are crenulate for at least a part of their length. The parapsidal furrows are usually straight or almost straight, although they frequently become wider and shallower behind and seem to curve toward each other just as they meet at a variable distance before the scutellar fossa, while a more or less distinct depression runs from their junction to the scutellar fossa. These furrows divide the mesonotum into three distinct lobes, the praescutum of the mesothorax, usually termed the median or middle lobe in descriptions, and the two parts of the mesoscutum, termed the lateral lobes.

The somewhat oval or oblong tegulae are located just below the widest portion of the mesonotum. The lateral lobes are narrowed behind, and then continued straight backwards till they end opposite the hind wall of the scutellar fossa, typically in a sharp, high vertical ridge which is continuous with that running along the whole margin of the mesoscutum and which runs downward and outward ending near the caudal portion of the attachment of the forewing. The surfaces of all three mesonotal lobes are sparsely punctured and hairy, although the extent of this varies according to the species. The scutellar fossa is large and deep, oblong in shape and closed at each end by a wall approximately equal in height to the surfaces it joins. The hinder wall is nearly vertical but the front wall may vary from nearly vertical to strongly sloping forward. The fossa is always bisected by a high carina longitudinal to the body, while there are a varying number of smaller or almost obsolete carinae parallel to this on each side of it. The scutellum is roughly triangular in shape, tapering behind, with the sides and apex strongly rounded off, and with the hinder, nearly vertical, face slightly elevated to form a more or less distinct, broad, transverse band, which is narrowest at the

median line. Below the rounded-off dorsal margins of the scutellum the sides form flattened, depressed, vertical faces, which are usually highly shining, and may be vertically ridged. The mesopleura form a five-sided, nearly flat area on each side of the thorax, running downwards and backwards from below the attachments of the forewings. Each is separated from the metapleurum by a smooth diagonal suture, while an incomplete, sometimes shallow, at least partially crenulated groove is all that separates the pleurum of each side from the venter, and it appears doubtful if it always represents the remnant of a suture. A strongly crenulated furrow parallels the hind margin of the pleurum for nearly all of its length, separating a relatively narrow band from the main portion, and this band appears to be all that is left of the epimeron of the mesothorax. A strip along the front margin, widening out strongly above, but variable in width according to the species, is slightly but sharply elevated above the rest of the mesopleurum. Usually this area is more closely punctate than the disk of the pleurum which is sparsely punctate and hairy.

A sharp crenulated ridge runs along the lower part of the front margin of each pleurum and continues around the same margin of the venter. The pleura and sternum are sharply truncate below in front, with the space thus formed curving backwards and downwards from the prothorax and receiving the fore coxae. The two halves of the sternum are rounded off on the sides, and separated medially by a sharp crenulate furrow. The venter is usually much more closely punctured and more hairy than the pleura, but there is no distinct line of demarcation between the two areas as regards frequency of punctuation.

The metanotum is a transverse plate, curving forwards on each side, with each outer hind angle rounded into a flat lobe, excavated on each side of the middle, and still more just inside of the attachment of the hind wings, while in the middle there are three high carinae which meet medially near the caudal margin of the metanotum. Two of these carinae run backwards on each side of the middle from the cephalic margin to form a triangular or nearly semicircular inclosure with its base forward, and the third ridge runs steeply, sometimes vertically, downwards until it almost meets a corresponding ridge of the propodeum, leaving a deep notch between the metanotum and the propodeum. The metapleura are roughly triangular in shape with the sharpest angle pointing forward. They show no traces of sutures separating the episternum and epimeron on each side, but there is a deep, very coarsely crenulate, nearly vertical, furrow running downwards from the suture between metanotum and propodeum and dividing the surface into two areas, the cephalic one long, triangular, with the base above and the apex just above the insertion of the middle coxa, and the caudal one occupying the remainder of

the pleurite, bounded above by the lateral propodeal carina, and drawn out below into an apically-pointed lobe above the middle coxa. The cephalic lobe varies somewhat in relative width according to the species, and its surface is smooth and sparsely punctured and hairy, but it has been almost completely ignored in specific descriptions, the references to punctuation and areolation concerning the hinder lobe only. This lobe has the disk shining and sparsely punctured and hairy, the whole margin more or less strongly crenulate, and anywhere from the narrow lower margin to the lower two-thirds of its surface roughened and irregularly areolate. The metasternum is hidden by the enlarged hind coxae.

The propodeum is nearly horizontal above, and usually gradually rounded off behind, although sometimes the two faces meet in a sharp angle, and the hinder face is even concave in some cases. The dorsal surface is coarsely and more or less regularly areolated, the main ridges consisting of three longitudinal ones on each side, the two median meeting before and behind, sometimes curving together, sometimes forming a pair of elongate isocles triangles with the bases together, the form of the pair varying with the species, and even somewhat in the species. The outer ridge on each side forms a boundary between the metapleurum and the propodeum. The ridge between the inner and outer ridges varies in its relative distance from the two, and is connected with them by a varying number of more or less prominent transverse ridges, while the two median ridges are usually joined by a number of prominent transverse carinae. There is a decided tendency, particularly in the males of some species, for the areolations to break down almost completely, and to leave a set of incomplete, twisted and curved, and often indistinct ridges. The surface of the propodeum is usually shining and hairy, at least on the sides, the hairs coming from obscure punctures. The depressions between the ridges are often roughened and irregularly wrinkled. The propodeal spiracle is large, oval, or oblong, placed diagonally with reference to the median line of the body, and located between the second and third longitudinal ridges on each side, usually in a shallow depression of the surface, although the spiracle itself is quite prominent by reason of the strongly elevated rim surrounding it.

Wings.—The wings are always darkened in the species of this genus and are usually fuliginous, with a few lighter spots as follows: In the forewings, with a lighter streak just behind the costal vein, and another just in front of the anal vein, with a small irregular area just behind the base of the stigma, and another beyond the point where the discoidal and first recurrent veins branch apart. The dark brown color of the veins is interrupted at the lower end of the transverse medial vein (nervulus), above the middle of the first recurrent

vein, at the junction of the first transverse cubital vein with the cubital vein, and at the lower end of the second transverse cubital vein. The whole surface of the wing is sparsely clothed with short, rather stout hairs, while there is a marginal fringe of stout hairs along the costal vein and the stigma. The terminal section of the cubital vein, the subdiscoidal vein (*nervus parallelus* of Szepligeti), and nearly all of the median vein are lighter in color than the rest of the veins and also appear to be much less developed. The hind wings are similar to the forewings in coloration and extent of hairiness.

I have not been able to determine with entire satisfaction the homologies of the venation according to the Comstock-Needham system, so I have used the older terms for the various veins and cells. The drawing of the wings will serve to show the arrangement of the venation, which seems to be quite constant for the genus. The first cubital and first discoidal cells are always united, although the base of the cubital vein is more or less developed; the areolet or second cubital cell is always four sided, and often approaches a parallelogram in shape, although usually the first transverse cubitus is more diagonal than the second.

Legs.—The legs are elongate and slender, with the hind pair distinctly but not prominently larger than the others. The coxæ are roughly conical in shape, and have the plainly two-segmented trochanters attached to their extremities. The femora are elongate, somewhat swollen for much of their length, gradually narrowed at each end. The tibiae are quite slender for a short distance beyond their attachment to the femora, and are then gradually swollen and enlarged for the remainder of their length, being nearly as thick as the femora at their apex. The fore tibiae appear to be without apical spines, but the middle and hind tibiae nearly always have a variable number of small stout spines at their apex, forming a group or cluster above the outer and smaller terminal tibial spur. The middle and hind tibiae have two spurs at their apex, the larger about half the length of the first tarsal segment and the smaller slightly shorter. These tibial spurs appear to be light colored in all of the species. The fore tibiae have a single apical spur, modified with the base of the first tarsal segment into an antennal comb. The first tarsal segment is about as long as the next three united, and in the hind tarsi is almost as long as all the remaining segments united. The tarsal claws are large, and in all the members of this genus the first two pairs are deeply and distinctly cleft, with the inner tooth flat and much larger than the outer. The hind tarsal claws vary from cleft to prominently toothed at the base. All of the legs are more or less hairy, the coxæ and femora smooth and shining, sparsely punctate and hairy, the tibiae much more closely punctured and hairy and somewhat roughened by the punctures, the tarsi thickly clothed with stout hairs, especially beneath.

Abdomen.—The abdomen is elongate, slender, lanceolate, with the first two segments dorsally flattened, margined along their sides, and strongly compressed below, the remainder rounded above, and tapering to the apex. If the fused second and third tergites be considered as two segments, there are eight dorsal segments in the female and six ventral, while the male has seven segments both dorsally and ventrally. The tergum of the first segment is narrow at its attachment to the propodeum between the hind coxae, and gradually widens to the apex. There is a median basal excavation and the sides are usually widened slightly at the spiracles which are located much nearer to the base than to the apex of the first segment. The tergites of the second and third segments are firmly united, the division between them at most taking the form of a very shallow faint transverse groove. The sides of these segments are also constricted to form a sharp margin for the tergite to a point slightly beyond the actual termination of the second segment. On the sides the suture between these two segments shows distinctly. The spiracles of the abdomen except the first are located on the sides of the segments, and all of them are small and round. There is a transverse fringe of relatively long upright hairs just before the caudal margin of all of the segments from the third on. The abdomen terminates in the ovipositor in the female, this consisting of a pair of closely locked valves forming an elongate, slender, linear tube approaching the abdomen in length, which is always pale red in color, pointed at the tip, and normally hidden by a pair of black sheaths, both of which are fully as long and are very slightly swollen at the tips, while they are strongly concave within and are sparsely clothed externally with rather stout hairs. The copulatory appendages of the male consist of three roughly triangular lobes, the median, dorsal one with a sharp median longitudinal ridge below, while the other two ventral lobes are flap-like. An examination of these lobes in the males of three widely separated species of the subfamily Agathinae failed to show any differences that appeared to be of value for even specific identification, so no further attempt was made to study the genitalia.

Pubescence.—All of the hairs of the body proper—that is, the head, thorax, and abdomen—seem to be light colored and often whitish. Their appearance is somewhat deceptive at times, however, as they are often translucent, and appear to take on the color or shade of the background against which they stand.

MEASUREMENTS.

With the exception of the sets of measurements given for the head, all of the lengths, as of the body, wings, etc., are given in millimeters. The head measurements were made with a micrometer eyepiece, with a scale 5 mm. in actual length and divided into 50 units, inserted in the right tube of a Zeiss binocular microscope.

The Zeiss eyepiece 4 and objective A₂ were used, giving a magnification of 65X. As these head measurements are at best merely relative, it was not thought worth while to reduce them to actual fractions of a millimeter.

ECONOMIC IMPORTANCE.

There are breeding and host records for only one of the American species of this genus. *Bracon vulgaris* (Cresson) has been reported as a parasite of the sugar-beet web-worm, *Loxostege sticticalis* Linnaeus, both by Dr. L. O. Howard of the Bureau of Entomology, United States Department of Agriculture,¹ and by Prof. C. P. Gillette, of the Colorado Experiment Station.²

SPECIFIC NAMES.

Although I am personally strongly opposed to such a policy, I have taken the names of several of the new species from those of various entomologists, since the transferal of the genus name *Bracon* to this group of species has brought into consideration over 800 valid specific names, and has practically eliminated the possibility of choosing a descriptive name somewhat characteristic of the insect which has not already been used for some species credited to the genus *Bracon*.

KEY TO THE SPECIES OF THE GENUS *BRACON* FABRICIUS (CREMNOPS OF FÖRSTER AND AUTHORS).

- a¹. Apical pits of the pronotum united, and forming a deep transverse groove across the apex of the pronotum.....*slossonae*, new species.
- a². Apical pits of the pronotum separated.
 - b¹. Apex of the antennal scape produced into a short tooth in front; body red, venter black, propodeum red in female, black in male; hind tibiae with a cluster of about 15 apical spines.....*vulgaris* (Cresson.)
 - b². Apical margin of the antennal scape rounded off, not produced into a point.
 - c¹. Hind angles of the mesoscutum produced into a finger like lobe on each side of the scutellum; black, abdomen red, propodeum variable; hind tibiae with 2 apical spines.....*comstocki*, new species.
 - c². Hind angles of the mesoscutum at most produced into a vertically compressed rounded lobe.
 - d¹. Head and all of the thorax in front of the metathorax black.
 - e¹. Propodeum and metathorax red.....*montrealensis*, new species.
 - e². Propodeum and metathorax black.....*ashmeadi*, new species.
 - d². At least the dorsum and part of the sides of the mesothorax red.
 - f¹. Thorax and propodeum black, except the dorsum and a portion of the mesopleurae and metapleurae; hind tibiae with two apical spines.....*kelloggii*, new species.
 - f². Thorax red, at most the prothorax and venter black.
 - g¹. Mesopleural furrow long, crenulate, curved upwards till its end is almost parallel with the suture between the meso- and metapleurum; propodeum black, the sides dull red; hind tibiae with an apical cluster of about 17 spines.
californicus, new species.

¹ Insect Life, vol. 6, 1894, p. 371, fig. 30.

² Colo. Agr. Exp. Sta. Bull. 98, 1906, p. 10, pl. 1, fig. 8.

*g*². Mesopleural furrow much shorter and straight, nearly horizontal.

*h*¹. Malar space at least slightly longer than the height of the eyes.

*i*¹. Tegulae and venter of female black; male not known; hind tibiae with an apical cluster of 8-10 stout spines, middle tibiae with 3-4 apical spines.

nigrosternum, new species.

*i*². Tegulae of both sexes and venter of female pale; hind tibiae with 4-7 apical spines, middle tibiae with 2, rarely 3, spines at apex,

szepligetii, new species.

*k*². Malar space shorter than the height of the eyes.

*j*¹. Labrum narrow, the sides nearly straight and parallel for a short distance; middle tibiae with 1-2, hind tibiae with 2 apical spines,

melanoptera (Ashmead.)

*j*². Labrum broader, the sides curved.

*k*¹. Mouthparts black or blackish; head and trochanters typically black or blackish; hind tibiae with from 2-13 apical spines, middle tibiae with 2 spines at apex,

haematodes (Brullé.)

*k*². Beak wholly red, thorax including the tegulae wholly red; hind tibiae with 2 apical spines, middle tibiae with 1, often 2 spines at apex.

virginiensis, new species.

BRACON SLOSSONAE, new species.

Plate 25, fig. 6; plate 27, figs. 13, 14.

Apical pits of the pronotum joined together and forming a broad transverse groove across the apex; size large; black, the propodeum, metathorax, and episternum of the mesothorax, abdomen, hind coxae and femora clear red; middle tibiae without spines at apex, hind tibiae with two apical spines. Length, 11 mm.

FEMALE.—*Head*.—Triangular, not quite as wide as long; length, 80; width, 73; height of eyes, 35; malar space, 32; width between eyes, 37; width at bottom of head, 25; head very thick as viewed from the side, profile of the face strongly bulging from the bottom to the insertion of the antennae, and the head projecting backwards to form a strongly arched lobe behind each eye; marginal ridges of the antennal pits prominent along the sides and below, but nearly obsolete from opposite the median ocellus to the bases of the paired ocelli; interantennal plates not sharply separated and not very prominent; the clypeal foveae small, round, located in a shallow, flat depression, and nearer to the eyes than to the bases of the mandibles; head shining, more or less densely clothed with whitish hairs, each inserted in a puncture, face and cheeks less shining and more closely punctured, vertex and occiput shining and smooth except for a small group of punctures behind each lateral ocellus; eyes

oval, the outline flattened behind and bulging in front, black; ocelli arranged in a triangle with the lateral ocelli nearer to each other than to the median ocellus; antennae about two-thirds the length of the body, stout, black, 42-segmented, thickest at segments 2-6, and gradually and uniformly tapering to the tip, scape short, broad and flattened; scape and second segment shining and sparsely punctured and black-hairy, the rest dull; labrum broad oval in outline, nearly circular, strongly arched transversely and straight in profile, black, sparsely punctured and hairy, the lower margin not elevated to form a marginal ridge; mandibles black; beak rather short, black, the labial lobes pale yellowish; maxillary and labial palpi black, with scattered whitish hairs, the first two segments of the maxillary palpi much thicker than the rest, and cylindrical, the third more slender and somewhat clavate, the fourth still more slender and clavate, the last relatively very slender and nearly cylindrical; the segments of the labial palpi much shorter, the first stout, cylindrical, the second stout, a little clavate, the third more slender, clavate, the fourth slender, nearly cylindrical; the last segments of both pairs of palpi translucent.

Thorax.—Black, the metathorax, mesepisterna and propodeum red; lateral lobes of the pronotum shining, lightly punctate and hairy along the upper margin, the hairs blackish; a deep transverse groove cutting across the apex of the pronotum, the front margin of this elevated to form a sharp ridge, slightly notched in the middle (pl. 27, fig. 13, 14), proepisterna thickly clothed with whitish hairs, giving a silvery appearance in some lights, this appearance most pronounced in two spots just below the attachment of the head; parapsidal furrows deep, rather broad, not punctured, widened in front, and the two meeting behind in a wide curved angle just before the scutellar fossa; the middle lobe of the mesothorax with a distinct median groove, the lateral lobes with a less prominent flattened groove down the middle of each; all the lobes shining and very sparsely punctured and set with dark hairs, the punctures thickest along the inner edges of the lateral lobes; hind angles of the mesoscutum not strongly produced; the transverse fossa preceding the scutellum broad and deep, with one prominent median longitudinal carina bisecting it, and sometimes with faint traces of smaller carinae on each side of the median carina; scutellum short, broadly triangular, with the hind margin rounded and strongly depressed, then followed by a short transverse ridge; mesopleurae shining, sparsely punctured, and hairy, more closely so along the front margin; mesopleural groove nearly obsolete, represented only by a broad depression in front of the middle coxae, the deep pit occurring above this groove in most species represented by a short groove with flattened sides; front edge of the venter produced into a prominent ridge notched in the middle, and

tapering out on the sides; venter shining, more thickly punctured and hairy than the pleurae; metanotum with a small, transverse, almost triangular arched plate in its middle, followed by a very short longitudinal ridge; metapleurae strongly crenulate around the borders, except in front, with a prominent ridge above the insertion of the hind coxae, this ridge meeting the outside ridge of the propodeum above to form a blunt tooth; most of the surface of the metapleurae shining and sparsely punctured and hairy, the lower border duller and coarsely rugose; propodeum in profile nearly horizontal above, the hinder face very sharply declivious, almost vertical, the two faces forming almost a right angle, coarsely areolate, with three well-defined longitudinal ridges on each side, the two median forming an elongate isocles triangle with its apex pointing forward, and with about 7 transverse ridges between the two; the spaces between the first and second and the second and third ridges on each side coarsely and more or less regularly wrinkled; spiracles elliptical, almost slit-like, the inner side more flattened than the outer.

Wings.—Length, fore 10.5 mm., hind 8 mm.; very dark fuliginous, with a pale streak behind the costa and another in front of the anal nervure, with a translucent spot immediately below the base of the stigma, another just beyond the branching of the discoidal and the first recurrent nervure, and the usual breaks in the cubital veins; venation typical of the genus.

Legs.—Fore and middle legs black, hind coxae and femora red, hind trochanters red with a blackish tinge, hind tibiae dark, almost black at base, dark red near the middle, and black at apex, hind tarsi black; all tibial spurs lighter at tip; apical segments of fore and middle tarsi lighter, dark reddish-brown; all tarsal claws cleft; middle tibiae without spines on the outer surface near the apex; hind tibiae with two apical spines above the smaller apical spur.

Abdomen.—Elongate, shining, red, sometimes irregularly blotched with blackish infusion; length, 5.5 mm.; spiracles of the first abdominal segment placed on small tubercles; ovipositor pale red, the sheaths black, length 3 mm.

Male.—Not known.

This species is described from two female specimens, collected at "Biscay Bay, Fla.," presumably by Mrs. A. T. Slosson, as Ashmead has given the specimens the manuscript name used above. These specimens, the type and paratype, Cat. No. 20476, are deposited in the collection of the United States National Museum.

The species is very distinct, and departs in many ways from the typical *Bracon*.

BRACON VULGARIS (Cresson).

Plate 24, figs. 1a, 1b, 1c; plate 25, figs. 2-6, 7; plate 26, figs. 8-12; plate 27, figs. 15-18, 20.

Agathis vulgaris CRESSON, Proc. Ent. Soc. Phila., vol. 4, 1865, p. 295; Trans. Amer. Ent. Soc., vol. 4, 1872, p. 182; Cat. Hym. N. A., Suppl. vol., Trans. Amer. Ent. Soc., 1887, p. 227.—SMITH, List of the Insects of New Jersey, 1909, p. 609.

Agathis media CRESSON, Proc. Ent. Soc. Phila., vol. 4, 1865, p. 295.—VIERECK, Trans. Kansas Acad. Sci., 1905, p. 277.

Agathis exoratus CRESSON, Trans. Amer. Ent. Soc., vol. 4, 1872, p. 182.—SMITH, List of the Insects of New Jersey, 1909, p. 609.

Cremnops vulgaris ASHMEAD, Colo. Biol. Assn. Bull. 1, 1890, p. 41.—HOWARD, Insect Life, vol. 6, 1894, p. 371, fig. 30.—DALLA TORRE, Cat. Hym., vol. 4, 1898, p. 183.—BRIDWELL, Proc. Kansas Acad. Sci., Dec. 30, 1898, p. 205.—CHITTENDEN, U. S. Dept. Agr. Bur. Ent. Bull. 43, 1903, p. 39.—SZEPLIGETI, Gen. Ins., Fasc. 22, 1904, p. 124.—GILLETTE, Colo. Exp. Sta. Bull. 98, 1905, p. 10.

Diosphyrus vulgaris MARSH, U. S. Dept. Agr. Bur. Ent. Bull. 109, pt. 6, 1912, p. 62.

Upper margin of the antennal scape drawn out in front into a small tooth; color mostly red, orange-yellow or honey-yellow; head more or less black on the cheeks, venter black, propodeum black in the male. Length, averaging about 8 mm., but varying from 6.5 to 9.5 mm.

FEMALE.—*Head.*—Triangular, slightly longer than wide; length, 61; width, 58; height of eyes, 27; malar space, 29; width between eyes, 32; width at bottom of head, 19; all these taken from an average size specimen; interantennal plates usually distinct, triangular in form, and separated by a more or less developed groove, which is generally triangular in shape; height and distinctness of the plates varying considerably in a large series of specimens; ridges bordering the antennal fossae distinct and strongly arched opposite the lower border of the median ocellus, continuous to the lateral ocelli; profile nearly straight, very slightly concave from the apex of the clypeus to the lower end of the flattened area; the whole face in section strongly arched transversely along the median line; the flattened area varying greatly in extent, and sometimes hardly evident, its median groove also varying in depth and length; face on flattened area sparsely and not heavily punctured, sides, lower end, and malar spaces highly shining and at most very sparsely punctate and hairy; head red, mouth parts and a portion of the cheeks black; eyes medium in size, usually dark; ocelli variable in color, arranged in a triangle with the lateral ocelli nearer to the median ocellus than to each other; antennae 35-36 segmented (from 20 specimens), black, except that the lower part of the scape up to four-fifths of it may be red like the head, leaving only an apical black band; scape not particularly

swollen, the upper margin distinctly, but sometimes not prominently drawn upward and forward in front to form a short obtusely angled tooth; labrum black or blackish, shining, sparsely punctate and hairy, longer than wide; mandibles pale, apex black; beak black.

Thorax.—Longer than high, red, the venter black; lateral lobes of pronotum shining, closely punctate along the upper border, disk very sparsely and faintly punctate, apical pits deep and distinct; propisterna rather coarsely and roughly punctured, shining, the apical lobes smooth, only slightly expanded and somewhat blackish; parapsidal furrows distinct, not so very deep, although this varies, typically, at least, distinctly and even rather coarsely crenulate for their whole length, even to the junction before the scutellar fossa, continued to the scutellar fossa as a shallow groove, sometimes almost obsolete; median furrow of the middle lobe distinct but usually rather shallow, the two lateral lobes flattened over part of their surface; the whole mesonotum shining and mostly smooth, very sparsely punctured and hairy; scutellar fossa more shallow than in some other species, the front wall sloping to the mesonotum, with at least a large median carina longitudinal to the body, and with traces of several others on each side of the middle one, these sometimes almost as prominent as the median ridge; scutellum triangular, the sides and apex rounded off; hind angles of the mesoscutum not prominently produced; mesopleurae shining, distinctly punctured and hairy; mesopleural groove rather deep, curving lightly upwards, coarsely crenulate; venter distinctly and rather closely punctured and hairy, black; metapleurae smooth and rather closely punctured above, more coarsely, closely, and roughly punctured below, shining; propodeum with six longitudinal ridges, the two median nearly or quite parallel for much of their length, converging suddenly in front, and very gradually behind, connected by a varying number of transverse ridges, and united with the lateral ridges on each side by a number of transverse ridges; in many specimens there is exhibited a tendency toward the formation of a fourth ridge on each side between the median and second ones; spiracles oval, but varying somewhat in shape.

Wings.—Length, average, fore 7.5 mm., hind 5.5 mm.; fuliginous, venation as shown in figure.

Legs.—Reddish, the trochanters black or blackish, more or less of the fore and middle femora dark, extreme tips of hind femora, bases, and apices of hind tibiae black, as are more or less of the extreme tips of the middle tibiae, fore tarsi pale, middle tarsi blackish except the bases, hind tarsi black; all tarsal claws black, fore and middle cleft, hind large-toothed at base.

Abdomen.—Elongate, lanceolate, slender, the first segment not extremely long and narrow, the remainder as described for the genus, sometimes more or less clouded irregularly with blackish infusion,

although usually clear red, or orange-red; length, average, about 3.75 mm., ovipositor pale red, valves blackish, about as long, or when fully retracted, a little shorter than the abdomen.

MALE.—Appears to resemble the female rather closely, except as follows: Head usually with considerably more black on the cheeks, and with the apex of the vertex around and between the ocelli black; propodeum and usually the metathorax black, more or less of the metapleurae often paler; generally all of the hind tibiae except a rather narrow band above the middle black or blackish; the distinct carinae of the propodeum often broken down, incomplete, irregular, not following the usual lines, curving and swirling.

Over 350 specimens of this species have been more or less carefully examined, although the detailed description was made up from not more than a score, selected from widely separated localities. By far the greatest number of specimens were collected in the State of Colorado, including about 130 collected in two hours' time by the writer near Eaton, Colorado, the latter part of August, 1914, and there are a sufficient number of specimens in the collection to show that the species also has a wide distribution in New Mexico, Arizona, Texas, and at least the western part of Kansas. In addition there are isolated records from West Point, Nebraska; Pierre, South Dakota; Mount Hood, Oregon; Milwaukee, Wisconsin; and, 12 specimens from the C. F. Baker collection labeled "Ind.," which I assume to refer to Indiana, although in general summer collecting over the State for several years past I have not come across this species. There is also a single specimen of this species in the collection labeled "near Phila."

The type of the species is located in the collection of the Academy of Natural Sciences in Philadelphia, there being a number of cotypes, without any designated type.

***BRACON COMSTOCKI*, new species.**

Hind angles of mesoscutum produced into relatively prominent, tapering, slightly curved finger-like projections on each side of the scutellum; at least the head and mesothorax black, and the abdomen red; metathorax, propodeum and legs variable in color; length 6.5–8 mm.

FEMALE.—*Head.*—Triangular; height, 53; width, 56; height of eyes, 26; malar space, 26; width between eyes, 32; width at bottom of head, 20; interantennal plates triangular in outline, separated by a triangular groove; face triangularly flattened below the antennae, this area grooved down the middle, this groove deepest and its flattened sides widest at the top; ridges surrounding the antennal fossae not especially prominent, highest before a point opposite the median ocellus, obsolete shortly before meeting the lateral ocelli; profile of face slightly

convex, the face bulging more in front of the eyes than in most species; face rather closely punctured and hairy along the middle line, less closely and more finely so below on the clypeus and on the cheeks, faintly longitudinally striate or wrinkled near the center; head black, end of clypeus sometimes slightly very dark reddish; compound eyes dark, size medium; ocelli dark, the lateral ocelli slightly but distinctly nearer to each other than to the median ocellus; antennae 43-45 segmented, the last segment sometimes indistinctly separated from the preceding, black except in imperfectly colored specimens, which are brownish black, the first two segments shining; labrum broader than long, black, with an indistinct paler band across the lower margin, sparsely punctate and hairy; mandibles black or dark; beak black or blackish; palpi with the last three segments of both translucent, dirty yellow, the basal segments blackish, all of the segments of the maxillary palpi nearly cylindrical, those of the labial palpi rather clavate, except the last; maxillary palpi about twice as long as labial.

Thorax.—Longer than high, black, often with more or less of the propodeum, metathorax, and legs red; lateral lobes of pronotum shining, nearly smooth in center, rather coarsely punctate and hairy around the borders, with the grooves paralleling the hind margins deeply crenulate but poorly defined; with the surface just below the apical pits vertically wrinkled, and the whole surface often more or less roughened; proepisterna less densely punctate and hairy than in many of the other species; pits at apex of the pronotum deep and large, but not produced very far downward on the sides; mesonotum shining, rather sparsely punctured and hairy; parapsidal furrows straight, fairly sharp and deep, meeting behind to form a sharp, shallow angle and continuing to the scutellar fossa as a single groove; typically shallowly crenulate, at least about their middle, but these crenulations apparently sometimes wanting in some specimens; median lobe of mesonotum shallowly excavated along middle line; lateral lobes also shallowly grooved down their middle; hind angles of mesoscutum strongly produced as already described; scutellar fossa deep and broad, with one prominent median longitudinal carina bisecting it, and with one or two smaller often indistinct carinae in each half; scutellum broadly triangular in outline, with the sides and apex strongly rounded off, so the shape is almost that of a parabola; the whole disk of the mesopleurae uniformly punctured, the venter a little more densely hairy; length of mesopleural furrow about half the width of the pleurae, the furrow deep and more sharply defined above, and directed diagonally upwards; metapleurae black or red, the lower two-thirds roughened and irregularly areolate, the upper third smoother and punctured; propodeum coarsely areolate, the median ridges converging slightly toward the front, and then meeting suddenly; spiracles elongate oval.

Wings.—Dark fuliginous, venation normal, the second transverse cubital vein occasionally with a spur running out from above its middle

Legs.—Fore and middle legs black, hind trochanters, tarsi, and at least the apices of the tibiae black; coxae, femora, and portions of the tibiae black or red; all of the tarsal claws cleft, the hind more deeply and broadly than the others; middle tibiae with one apical spine, hind tibiae with two apical spines above the smaller spur, in a single specimen with one apical spine present.

Abdomen.—Elongate slender, wholly red, the first segment rather broadly triangular; the tergum of segments two and three with an obscure transverse groove to indicate the division between the two, and with a low transverse hump across the base of the second tergite; length about 3.5 mm.; ovipositor red, sheaths black, length 2 mm.

Described from 12 females.

MALE.—Apparently resembles the female in all essential structural characters, except that the number of antennal segments varies from 40–42.

This species appears, so far as the specimens examined may be used as an indication, to occur in four distinct color varieties, which are more or less definitely limited in distribution. I have been unable to find any structural characters which would separate these groups of specimens, and I believe that a larger series would show complete intergradation, so I have merely tabulated these color variations as follows:

- a¹. All the legs wholly black.....Var. *A*.
- a². Hind legs except the trochanters, tarsi and ends of tibiae, red.
 - b¹. Propodeum and thorax wholly black.....Var. *B*.
 - b². Propodeum and metapleurae at least partly red.
 - c¹. Propodeum and metapleurae wholly red.....Var. *C*.
 - c². Propodeum blackish in front; metapleurae almost wholly black or blackish.....Var. *D*.

Var. *A* is represented by 5 specimens; 1 female from Freeville, New York, in July; 1 from Ithaca-Ellis, New York, in June; 1 female and 1 male from Princeton, Maine, July 12; another male without data.

Var. *B* is represented by 10 specimens; 1 female from New York; 1 female from Great Falls, Virginia, June 20; 1 female from Roberts, Pennsylvania, July 4; 1 female from Agricultural College, Michigan, July 6; 1 female from Enola, Pennsylvania, September 18; 3 females and 1 male from Inglenook, Pennsylvania, June 20.

Var. *C* is represented by 5 specimens; 3 females from Dallas, Texas, May 1 to October 7, the latter from Polygonum; 1 male from Paris, Texas, August 27; and 1 male from Mound City, Louisiana, April 2.

Var. *D* is represented by 2 females; 1 from Falls Church, Virginia, June 19; and the other from Glencarlyn, Virginia, June 30.

Type.—Cat. No. 20477 U.S.N.M.

BRACON MONTREALIENSIS, new species.

Agathis liberator PROVANCHER, Le Nat. Can., vol. 12, 1890, p. 176.

Agathis semirubra SMITH, List of the Insects of New Jersey, 1900, p. 608.

Cremnops semirubra BANKS, Ent. News, vol. 23, 1912, p. 108.

Black, apical border of labrum pale; metathorax, propodeum, and abdomen red; length, 6-8 mm.

FEMALE.—*Head.*—Triangular, dimensions of typical specimens as follows: Height, 56; width, 62; height of eye, 30; malar space, 25; width between eyes, 33; width at bottom of head, 19; interantennal plates triangular in outline, separated by a triangular groove, and with a median groove running for a short distance down the face; profile of face nearly straight on the clypeus, slightly emarginate opposite the clypeal foveae, then slightly bulging to the flattened area below the antennae; ridges surrounding the antennal fossae rather prominent, arched, highest opposite the median ocellus and continuous to the lateral ocelli; head black, sometimes paler behind the eyes; face shining, fairly closely punctured and hairy in the middle, more lightly but nearly as closely punctured on the sides and below; compound eyes relatively large, dark; ocelli pale, the lateral ocelli typically slightly nearer to the median ocellus than to each other, although this appears to vary; antennae 39-40 segmented, black, the first two segments smooth and shining; labrum black, lower border pale tawny, wider than long, sparsely punctate and hairy; mandibles black, beak black, margins of lobes paler, palpi black, or blackish, maxillary palpi less than twice as long as labial.

Thorax.—Longer than high, black; metathorax and propodeum red; lateral lobes of pronotum smooth and shiny, sparsely and finely punctate and hairy around the edges, the pits deep and broad, propisterna closely punctured and hairy, the apical lobes highly polished and broader than in most species, being produced laterally; mesonotum shining, fairly smooth, sparsely punctured and hairy; parapsidal furrows straight, well defined, crenulate, sometimes obscurely, the side walls flattening out behind; longitudinal groove of the median lobe relatively deep and narrow, lateral lobes flattened over much of their surface, hind angles of the thorax slightly produced into a broadly rounded vertically compressed plate, scutellar fossae transversely broad and deep, with a prominent median longitudinal carina and one or more very indistinct lateral carinae on each side of the median carina; scutellum triangular, rounded off behind and on the sides, punctured and shining; mesopleurae shining, sparsely punctured and hairy over the whole disk, more densely so below and on the venter; mesopleural furrow deep, and very coarsely crenulate, longer than half of the width of the pleurae, not quite horizontal, metapleurae shining, roughened only along the lower margin, sparsely punctured and hairy over the whole surface; propodeum strongly areolate, the

median longitudinal carinae converging steadily from behind forwards, and united by a number of prominent transverse carinae; spiracles oval, the propodeum somewhat excavated behind them.

Wings.—Dark fuliginous, venation normal, sometimes with traces of a spur running out from the second transverse cubitus; length, fore 8 mm., hind, 6.5 mm.

Legs.—Fore and middle legs black, hind legs red except the basal segment of the trochanters, the tarsi and the bases and apices of the tibiae. Fore and middle tarsal claws cleft, hind long-toothed; hind tibiae with two short, blunt spines outside at the apex.

Abdomen.—Length, of 8 mm. specimen, 4 mm.; bright red, elongate, slender, lanceolate, the first segment relatively stout, second segment with a faint semicircular elevation at the base, the depression indicating the division between the second and third tergites very indistinct; ovipositor red, sheaths black, length 3.5 mm.

MALE.—Appears to resemble the female in all essential structural characters, including the number of antennal segments, although the antennae are sometimes as low as 37-segmented; with a varying amount of blackish diffusion over the dorsum of the abdomen in some species, this near the middle or apex. Described from 29 females and 37 males whose collection records show that the species is common from Montreal, Canada, to Virginia, along the Atlantic coast, and through New York and Pennsylvania westward to Michigan and Illinois, while there are isolated records from "S. D." (South Dakota), Milwaukee, Wisconsin, Pyziton, Alabama, and Texas (Belfrage coll.).

I have found this species labeled as *Agathis* or *Cremnops semi-rubra* Brullé in some collections, but it is obviously not that species, the matter of length alone precluding such a possibility, as *semi-rubra* is given as being 11 mm. long.

Type.—Cat. No. 20483 U.S.N.M.

BRACON KELLOGGII, new species.

Size small, length 5½–6 mm. black, dorsum and a little of the upper half of mesopleurae and metapleurae, hind coxae and femora, and abdomen, yellow-orange.

FEMALE.—*Head*.—Triangular, slightly higher than wide; length, 43+; width, 42.5; height of eye, 20+; malar space, 18; width between eyes, 25.5; width at bottom of face, 15; profile of face made up of two very slight curves, the first running from the base of the labrum to opposite the clypeal foveae, the second curve running from here to between the antennae; face with a short groove, deeper above, between the antennal plates; antennal plates distinctly separated, but not very high or large; the ridge of the antennal fossae almost uniform in height, a very little higher opposite the median ocellus, continuous to the lateral ocelli; head black, shining, rather

closely punctate and hairy, the hairs tawny; ocelli equidistant from each other; antennae black, the scape and first flagellar segment shining, the rest dull, more than 30-segmented (broken); labrum broad for the genus, almost semicircular in outline, black, slightly less punctate and hairy than the face; mandibles curved at tip, bidentate, the inner tooth short, the outer much longer and curved, black, beak black, the basal segments of both palpi only slightly thicker than those following, all the segments except the last tending toward a clavate shape, the last nearly cylindrical, tapering slightly at each end.

Thorax.—Black, caudal half of lateral lobes of pronotum, mesoscutum, a large portion of the middle of the mesopleurae, base of scutellum and upper half of metapleurae red; dorsum and cephalic half of the pronotum black, this shining, finely punctate around its borders, the pits rather large and pointed below, the front borders of the pits straight, the diagonal depression highly polished and smooth; proepisterna black, only slightly shining, more coarsely and closely punctate and hairy; parapsidal furrows of the mesonotum distinct and rather sharply defined, the median lobe divided by a narrow shallow longitudinal groove, the two halves flattened a little; the two lateral lobes only slightly flattened; hind angles of the mesoscutum only slightly produced; fossa of the scutellum not very deep, with only the median carina distinct, profile of scutellum evenly curved to tip which is lightly elevated, sides uniformly rounded off, triangular in shape with the tip truncate; mesopleurae smooth, shining, sparsely and faintly punctate and hairy, the front border and all of the lower half black, the remainder red; venter black, tegulae black; pleurae bulging somewhat above the furrow, this straight, horizontal, well defined and crenulate, and in length less than half the width of the pleurae; metathorax black, the upper third of the pleurae reddish; metapleurae smooth, shining, slightly more sparsely and coarsely punctate and hairy than are the mesopleurae, the lower hind corner roughened; propodeum black, with six longitudinal keels, the two median converging uniformly in front to form an elongate triangle, and meeting behind in a much sharper angle, with only one distinct transverse carina, which forms the base of the triangles; profile gently rounded above, but with the caudal face slightly distinct from the general outline; spiracles oval.

Wings.—Infuscated, venation typical, the second cubital cell trapezoidal; fore wing, 5 mm.; hind wing, 4 mm.

Legs.—Fore and middle coxae, trochanters, and femora black, the tibiae dark and with a strong blackish tinge; fore tarsi paler reddish, tarsal claws black, middle tarsi same color as tibiae, claws black; hind coxae red, black beneath and behind, trochanters black, femora honey-yellow, tips and all of tibiae and tarsi dark reddish brown,

almost blackish; fore and middle claws deeply cleft, hind, toothed; with 1-2 spines at apex of middle tibiae, and with three apical spines at end of hind tibiae.

Abdomen.—Three mm. long, honey-yellow, most of the first two segments darker, the sides and dorsum of the first segment blackish to behind the spiracles, the first segment relatively broad at its apex in comparison to its length, not flattened but gradually elevated caudally till near the hind margin, then rather sharply rounded off; the fossa at its attachment to the propodeum broad, deep, and relatively long, the sides parallel for a little distance; the spiracles set on small protuberances; ovipositor yellow, sheaths dark reddish brown, length, 3 mm.

MALE.—The male closely resembles the female except in the following characteristics: Color: With the exception of a little along the upper border of the lobes of the pronotum and on the upper third of the front part of the mesopleurae, there is no light color on the pleurae, while the abdomen is uniform reddish-yellow in color: Structure: The profile of the face is different, the sides of the labrum more nearly angulate, the groove running downward from between the antennal plates is very short and the whole middle of the face is slightly depressed below the end of the groove; the mesopleural furrow is a little longer, and runs upward instead of horizontally; the transverse carinae connecting the longitudinal ridges of the propodeum are more irregular and less distinct than in the female.

Described from two specimens, 1 female and 1 male, labeled "Nev." and from the collection of the American Entomological Society, but in the possession of the United States National Museum. This species was given the manuscript name of *discoidea* by Ashmead.

Type.—Cat. No. 20478 U.S.N.M.

***BRACON ASHMEADI*, new species.**

Size rather small for the genus, length 6 mm., black, abdomen red, hind angles of metathorax produced into a rather prominent vertically compressed lobe.

FEMALE.—*Head*.—Triangular, slightly wider than high; height, 49; width, 51; height of eye, 26; malar space, 20; width between eyes, 26; width at bottom of head, 16; interantennal plates distinctly separated; face below these triangularly flattened for one-third of its length and with a median groove from the interantennal plates dividing most of its length; ridges around the antennal fossae not very prominent, highest opposite or a little behind the middle of the median ocellus, continuous to the lateral ocelli, or slightly obsolete, just before reaching them; profile of face nearly straight below the flattened area; face rather closely punctured and hairy in the middle just below the antennae, more sparsely and finely punctate

on the clypeus and on the sides; face shining, the depressions on either side above the antennae highly polished, not punctured; head black, palpi tawny; compound eyes relatively large, dark; ocelli pale, almost equidistant from each other; antennae 35-segmented, black, the first segments shining, the rest dull, largest about the sixth segment, from there gradually tapering towards the tip; labrum about as long as wide, black, the lower margin tawny, coarsely, sparsely, and irregularly punctured and hairy; mandibles tawny, dentate, tips black; beak rather short, black, palpi dull yellow with a blackish shade, the first two segments of the maxillary palpi distinctly larger than the rest, the segments of the labial palpi relatively short and stout, successively more slender from base to apex.

Thorax.—Thorax longer than high, wholly black, lateral lobes of pronotum smooth and shining in the middle, closely and finely punctate around the margins, the punctures coarser below; pits of pronotum large and with distinct marginal ridges; proepisterna closely punctured and hairy and somewhat roughened, except for the lobes above the coxal insertions, which are smooth; parapsidal furrows well defined, smooth before and behind, more or less distinctly crenulate in the middle, straight, meeting a short distance before the scutellar fossa, and continuing as a single median groove to it; median lobe grooved broadly but rather shallowly down its middle, the lateral lobes shallowly grooved longitudinally, the whole surface of the mesonotum shining, sparsely punctured and hairy; hind angles of the mesoscutum distinctly produced into a vertically compressed lobe; scutellum tapering behind, the sides and apex much rounded off, the scutellar fossa broader than usual as the front wall slopes gradually upward, with a prominent median carina and a single much smaller one dividing the two halves of the fossa; mesopleurae shining, very sparsely punctured and hairy on the disk, more closely above and on the venter; furrow about two-thirds the width of the pleurae, straight, very coarsely crenulate and almost horizontal, metapleurae shining, coarsely and sparsely punctured and hairy, the lower third roughened and irregularly areolate; propodeum areolate, the median ridges converging very gradually from behind forward, then coming together suddenly in front; spiracles elongate oval, the propodeum shallowly excavated behind them and between the two lateral ridges.

Wings.—Fuliginous, venation and light spotting typical, the first transverse cubitus, forming the inner side of the areolet, running more diagonally outward than usual.

Legs.—Entirely black, or in some lights black with a faint dull reddish tinge, the last segment of the middle and hind tarsi and tibial spurs pale; fore and middle tarsal claws cleft, hind long-toothed, almost cleft, middle tibiae with 1-2 apical spines; hind tibiae with 2-3 spines.

Abdomen.—Length, 3 mm.; first abdominal tergite relatively broad and stout, second tergite with an indistinct line indicating the division between the second and third segments and with a slight, poorly defined semicircular elevation across the base, the whole abdomen red without blackish infusion; ovipositor pale red, sheaths black, length 3 mm.

MALE.—Appears to resemble the female very closely, except that the median ridges of the propodeum converge steadily from behind forward forming an elongate isoceles triangle; while the spiracle is more truly oval than in the female.

Described from two females—one, the holotype, from "Sou. Ill." collected by Robertson, the other labeled "Minn.," and from two males, the allotype from "Ks" (Kansas) 2138, coll. C. F. Baker, the remaining paratype from Lexington, Kentucky.

Type.—Cat. No. 20480 U.S.N.M.

BRACON CALIFORNICUS, new species.

Large, fossa of mesopleurae crenulate, curved upward, toward the end almost parallel to the suture between mesopleurae and metapleurae; body honey-yellow, propodeum black, caudal portion of metapleurae black, dark dull red in the center; length, 9 mm.

FEMALE.—*Head.*—Triangular, wider than long; length, 64; width, 67; height of eye, 32; malar space, 30; width between eyes, 37; width at base of beak, 24; profile of face very slightly concave to a little below the eyes, then slightly concave on another angle to the apices of the interantennal plates; marginal ridges of antennal pits well developed and extending to the lateral ocelli, most prominent opposite the median ocellus, and nearly obsolete above this; interantennal plates fairly well developed; head smooth, shining, sparsely punctured and hairy, the hairs whitish; ocelli arranged in a triangle, the lateral ocelli nearer to the median than to each other, each surrounded by a somewhat circular darker area; antennae black, nearly cylindrical at the middle, but tapering toward the tips; the first and second segments shining, the rest dull, 40-segmented; labrum elongate, strongly arched transversely, pale yellow, margined by a blackish-brown line, punctate and hairy; mandibles blackish brown at base and apex, yellowish in the middle; beak black, palpi black, the first two segments of each heavier and thicker, the rest more slender; all segments of maxillary palpi slightly clavate, last almost cylindrical; segments of labial palpi stouter and more strongly clavate, except the last which is nearly cylindrical; labial palpi more than half the length of the maxillary palpi.

Thorax.—Elongated, honey-yellow, propodeum black, caudal half of metapleurae black, dark dull reddish in center, pronotum shining, sparsely punctate and hairy except along the edge next to the meso-

notum and along the lower front margin where it is very closely and finely punctate and hairy; the surface very faintly almost vertically rugose below the lateral pits, these pits large, with an inner and an outer ridge on the caudal side; proepisterna more closely punctured and with larger hairs, the lower end above the coxal insertions on each side with a poorly defined transverse blackish band; parapsidal furrows fairly well defined, not punctured, apparently nearly obsolete behind, median lobe grooved, lateral lobes flattened in the middle; hind angles of the mesoscutum not prominently produced; fossa between mesonotum and scutellum with a median and one or two lateral ridges on each side; scutellum elongate, triangular, apex almost truncate; mesopleurae shining, sparsely punctured and hairy, with a well-defined but not deep crenulate fossa running forward from the insertions of the meso-coxae and curving strongly upward near the end; propodeum rounded in profile with three well-defined longitudinal ridges on each side, the median pair parallel for part of their length, uniting to form an oval in front, and in the shape of an elongate truncate triangle behind, the second ridge irregular and incomplete, the third nearly straight; spiracles short, oval.

Wings.—Fuliginous; length, fore wing 7 mm.; hind wing, 5.5 mm.; venation typical, with a large hyaline spot below the base of the stigma and another large irregular transverse mark just beyond the branching of the discoidal and the first recurrent nervure.

Legs.—Honey-yellow except all the tarsal claws, the apices of the hind tibiae and the hind tarsi; fore and middle tarsal claws cleft, hind claws missing, hind tibiae with an apical cluster of about 17 short, stout spines, middle tibiae with 2 stout spines.

Abdomen.—Elongate, slender, sides almost parallel, 4 mm. long, shining yellow with blackish infusion near the caudal end of the dorsum of third segment and some along the under sides of the same segment; dorsum of segments two and three very long, much longer than first segment; ovipositor brownish-yellow, sheath blackish, 4 mm. long.

MALE.—Not known.

Described from one specimen labeled "Sou. Cal. Am. Ent. Soc. Coll.," but now in the United States National Museum collection.

Type.—Cat. No. 20481 U.S.N.M.

BRACON NIGROSTERNUM, new species.

Malar space longer than height of eyes; reddish yellow; tegulae and venter of female black; length, 7–8 mm.

FEMALE.—*Head*.—Elongate, triangular, longer than wide; height, 62–57; width, 58–54; height of eye, 28.5–25; malar space, 30–27; width between eyes, 31–31; width at base, 18–17.5; profile of face slightly curved to a little below the antennae, then with a very faint

flat tubercle and straight to the antennae; face from the end of the clypeus to the slight tubercle, strongly arched transversely, and almost triangular in section, but spreading out to form a triangular flat area below and between the antennae, this area faintly grooved down the middle; the ridges bounding the antennal pits plainly extending to the lateral ocelli, and most prominent opposite the median ocellus. Head in one specimen dark red, overspread with blackish, especially around the antennae and over the cheeks; an oval lighter spot just below the frontal tubercle, lighter below the inner lower corner of the eyes, and almost the color of the body behind the upper half of the eyes. In the second specimen the head is red, overspread with blackish, with a band, broadest at the ends, across the face opposite the lower half of the eyes and a large area behind the upper half of each eye, the color of the body; head distinctly punctate, and clothed with long whitish pile, the punctures larger below and between the antennal pits; eyes relatively rather small; ocelli arranged in a triangle with the two lateral ocelli somewhat nearer to the median than to each other; antennae about 6.5 mm. long, black, segments one and two shining, punctured and hairy, the rest dull and hairy; 36-segmented (one antenna); labrum black, shining, relatively broad, somewhat more punctured and hairy than the face; mandibles black, palpi black, all of the segments at least approximately cylindrical.

Thorax.—Longer than high, red; tegulae and venter black; pronotum shining, closely and finely punctate and hairy along margins, the pits above large, elongate oval, pointed below and followed by a few indistinct vertical ridges in the depression of the lateral lobes of the pronotum; reddish yellow; cephalic margin black above, in the middle, and near the lower ends of the lateral lobes; proepisterna darker, the lower ends of the lobes broadly black; mesonotum shining, rather finely and sparsely punctate and hairy, the parapsidal furrows large and deep, but broad and not sharply limited, straight, meeting just before the scutellar fossa, with a slight median depression running to the fossa; median lobe broadly grooved, the middle of the groove slightly elevated, lateral lobes broadly flattened, hind angles of mesonotum produced into nearly vertical, almost triangular plates, prescutellar fossa deep, with a large median longitudinal carina, and a much smaller incomplete one on each side; scutellum triangular, truncate behind, the sides rounded off; mesopleurae shining, sparsely punctate and hairy, the mesopleural furrow straight, length equal to about one-half the width of the pleurae; deep and strongly crenulate; venter smooth, hairy, black; upper part of metapleura smooth, shining, punctured, and hairy; lower third coarsely rugose; profile of propodeum uniformly curved to the insertion of the abdomen, with six carinae, the two median nearly parallel, converging slightly in front, meeting before and behind in a definite angle, with three trans-

verse ridges between them; the two lateral ridges on each side joined to each other and to the median by several transverse carinae; spiracle broad oval.

Wings.—Infuscated, darker behind and basad of the stigma, venation typical, second cubital cell trapezoidal, the second transverse cubitus in both wings of one specimen with a very short spur branching from above its middle into the third cubital cell; forewing, 7.5 mm.; hind wing, 6 mm.

Legs.—Fore and middle coxae and all trochanters black; hind coxae red, tips blackish, basal third of fore femora, all of middle femora, and extreme base and apex of hind femora blackish, rest reddish-yellow; fore tibiae yellow, middle and hind tibiae black, fore tarsi pale, middle and hind black, all tarsal claws black, fore and middle cleft, hind large-toothed, nearly cleft; middle tibiae with 3-4, hind tibiae with 8-10 stout apical spines.

Abdomen.—Elongate lanceolate, length 3.5-4 mm.; length of ovipositor, 4 mm., reddish-yellow, sometimes with internal irregular blackish diffusion above; ovipositor yellow, sheaths black; first segment elongate, rather slender, proportions, length, 3.5+; width at apex, 2.2; width at base, 1; spiracles projecting slightly on each side; dorsum of segments two and three, smooth and shining, with a broad very shallow depression just behind the base, and an indistinct transverse line separating the two segments.

MALE.—Not known.

Described from two female specimens, holotype from Southern Pines, North Carolina, collected by A. H. Manee, May 21, 1908, and from the collection of N. Banks, and the other from Brandtsville, Pennsylvania, July 24, 1910, collected by H. B. Kirk, and from the collection of P. R. Myers.

Type.—Cat. No. 20479 U.S.N.M.

BRACON SZEPLIGETHI, new species.

Size medium, length, 6.5-8 mm., malar space slightly but distinctly greater than the height of the eyes; parapsidal furrows crenulate, red, mouth parts, antennae typically, trochanters and tips of middle and hind tibiae more or less, hind tarsi except base of first segment, blackish; abdomen often with blackish infusion.

FEMALE.—*Head*.—Triangular, slightly longer than wide; length, 56; width, 53; height of eye, 25; malar space, 27; width between eyes, 29; width at bottom of beak, 16; most specimens with the actual measurements greater but the proportions approximately the same; interantennal plates distinct, rather close together, a triangular area below them flattened and slightly grooved medially; ridges above the antennal pits highest opposite the median ocellus, continuous to the lateral ocelli; face in profile nearly straight to the flat-

tened area below the antennae; head smooth, shining, lightly punctate and hairy; color typically reddish honey-yellow, with the mouth parts, usually including the labrum, blackish; ocelli and eyes usually dark; ocelli arranged in a triangle, the lateral ocelli a little farther from each other than from the median ocellus; antennae 37-segmented, typically black, but brownish in imperfectly colored specimens, the base of the scape often paler, the first and second segments shining, the rest dull; labrum almost as long as wide, sides strongly curved, apex very slightly truncate, typically blackish, but colored like the head in some specimens, smooth, shining, with scattered punctures and hairs, and very finely punctate; mandibles the color of the head, the tips black, beak black; maxillary palpi a little less than twice as long as labial palpi, first segment the thickest, second the longest, cylindrical or very slightly clavate, slightly more slender than the first; last segment the most slender, tapering toward the tip, a little longer than the fourth; all segments except the last diagonally truncate at tip.

Thorax.—Slightly longer than high, red; pronotum with lateral lobes smooth and shining in the middle, closely and finely punctate around the margins; proepisterna closely and finely punctate and hairy, mesonotum sparsely punctured and hairy with the parapsidal furrows deep and crenulate, meeting in a sharp angle behind; median lobe somewhat flattened, with a broad shallow groove down the front two-thirds, this groove elevated longitudinally in the middle; lateral lobes flattened; hind angles of mesonotum slightly produced and flattened vertically; scutellum triangular, apex slightly rounded, sides rounded off and slightly concave, the triangular flattened area on the sides of the scutellum transversely ridged; fossa preceding scutellum deep, with one large median transverse carina and two small more or less distinct ones on each side; mesopleurae smooth, shining, sparsely punctate and hairy, the venter much more closely punctate and hairy; mesopleural furrow deep, straight, coarsely crenulate, length about two-thirds the width of the pleurae; metathorax shining, rather coarsely but sparsely punctured, rugose around the margins; median ridges of the propodeum meeting in front, typically convexly curved gradually away from each other to the hind margin of the dorsal face of the propodeum, and joined together there by a transverse ridge, sometimes suddenly separating in front and then nearly parallel for the rest of their length; the spiracle oval with the inner side flattened.

Wings.—Fore wing, 5.5–7 mm.; hind, 4.5–6 mm.; fuliginous, lighter spots as usual, second transverse cubitus sometimes with a spur at or near its middle.

Legs.—Reddish, typically with the trochanters darker to blackish; the extreme apices of the intermediate tibiae and more or less of the

bases and apices of the hind tibiae dark to blackish; fore and middle tarsi pale, except the claws; hind tarsi blackish except base of first segment; trochanters, tarsi, and tibiae sometimes wholly or in part pale; fore and middle tarsal claws cleft, hind toothed; middle tibiae with two, rarely three, apical spines, hind tibiae with from four to seven apical spines.

Abdomen.—3–4 mm. long, slender, first segment elongate and slightly widened toward the apex; red, nearly always with more or less blackish infusion, this usually near the apex of the abdomen, but sometimes at the apex of the first segment and on the second and third segments; ovipositor 4–5 mm. long, pale red, the sheaths black.

Described from seven females; specimens from Woods Hole, Massachusetts, to Texas, including Indiana, Florida and Kansas.

MALE.—Similar to the female, except for the following: Length, 7–8 mm.; color of head varying from entirely black, except for a small pale area behind each eye and a trace of a paler spot above the labrum, to entirely red, except for the mouth parts; proportions of head relatively the same as in the female; antennae 39–40 segmented, the last two segments rather indistinctly separated in the three specimens with 40-segmented antennae; parapsidal furrows apparently not crenulate in two specimens, but this seemingly due to their being partially filled with fused foreign matter; the smooth apical lobes of the propisterna, the front coxae—at least beneath—the venter, and a band on the outer sides of the intermediate coxae blackish or black, sometimes indistinct in old faded specimens.

Described from 15 males from various parts of Texas (12), Florida (2), Falls Church, Virginia (1).

In addition to the above specimens I have included here one female and one male specimen, each labeled "Va., July 25, '80, thru C. V. Riley," which are only about 6 mm. long and are very much paler than the lightest of the above specimens, there being no blackish markings except at the apices of the hind tibiae and the hind coxae, which are darker; the antennae are brownish, and there is a little blackish infusion on the dorsum of the abdomen. Structurally these specimens seem to agree specifically with this, and they present every appearance of being poorly nourished bred specimens which were killed and pinned before the coloring had fully developed.

Type.—Cat No. 20482 U.S.N.M.

BRACON MELANOPTERA (Ashmead).

Cremnops melanoptera ASHMEAD, Proc. Calif. Acad. Sci., ser. 2, vol. 4, 1896, p. 125.—SZEPLIGETI, Gen. Ins., Fasc. 22, 1904, p. 124.

Size small for the genus; honey-yellow; labrum narrow and with the sides apparently parallel for a short distance; length (male), 6.5 mm.

Head.—Triangular, about as wide as high; length, 54–51; width, 53; height of eye, 26; malar space, 24–22; width between eyes, 31–30;

width at end of head, 22-21.5; profile of face nearly straight or very slightly convex as far as the lateral facial pits, then very slightly convex to shortly below the eyes, then flat to the apices of the interantennal plates; marginal ridges of the antennal fossae well developed, less prominent behind the median ocellus; honey-yellow, one specimen not marked with darker coloring, the other with blackish-brown diffusion below and behind each eye, this extending forward on the face till only a narrow light stripe is left, and downward to the base of the mandibles, but with a lighter area above the base of each mandible; head pale in front of and behind the eyes, the darker coloring reaching the eye margin at the top of the eye and at the lower hinder corner of each; antennal fossae, vertex, and occiput black, lighter around the edges of the diffusion; face between antennae brownish; head sparsely punctate and clothed with white hairs; antennae black, brown in incompletely colored specimens, more than 24-segmented (broken); eyes dark; ocelli arranged in a triangle, the lateral ocelli slightly nearer the median ocellus than to each other; labrum elongate, pale, honey-yellow, the thickened margin pale brown in the lighter specimen and blackish-brown in the darker; mandibles pale, blackish at tips; beak and palpi pale brown to blackish brown, the terminal segments of the palpi rather stouter than usual in the lighter (male) specimen, longer and apparently more slender in the darker (female?) specimen.

Thorax.—Longer than high, honey-yellow, venter light or reddish-brown; pronotum with sides shining, almost smooth in the middle, but finely and more densely punctate along the upper and hinder margins; proepisterna pale honey-yellow, varying to dark reddish-brown, the lower ends of the lobes darker in each case; parapsidal furrows prominent, deep, more groove-like than usual, not punctured, continued straight backwards and meeting to form an acute angle just before the scutellar fossa; median lobe of mesothorax with a broad and shallow but distinct median groove; lateral lobes flattened; fossa with a rather prominent median ridge, and a second fainter ridge close to it on each side; scutellum typical; mesopleurae sparsely and faintly punctate and hairy, the pleural groove running straight forward from the middle of the insertion of the middle coxae, for about a third of the width of the mesopleurae, deep and well defined, but becoming uniformly shallower until it fades out entirely; venter darker, more closely punctate and hairy; metapleurae smooth and shining, sparsely punctate and hairy; profile of the propodeum almost uniformly rounded to the insertion of the abdomen; the propodeum with six longitudinal keels, the two median well separated, farthest apart a distance of about one-third of their length from the hind margin of the propodeum, gradually converging forward and round-

ing into each other, behind converging slightly to the hind margin; with about four more or less distinct transverse keels between these and with other transverse keels connecting the lateral keels to each other and to the median pair; spiracles elongate-oval, almost elliptical.

Wings.—Light fuliginous, with the usual transparent spots; venation typical; fore wing 7 mm., hind wing 4.75 mm.

Legs.—Honey-yellow; trochanters more or less brownish; fore and middle tarsal claws dark, cleft, hind tarsi wanting; no spines on middle tibiae.

Abdomen.—(From a single male specimen.) Elongate, length 3 mm., honey-yellow; smooth, shining, and with whitish hairs; first segment rather stout.

Redescribed from two specimens from Los Angeles, California, probably collected by Coquillett. In one of the specimens the structural character which I have used as distinctive is less pronounced than in the other, and this, in connection with some other more minute differences, leads to a little uncertainty as to the specific agreement of the two specimens. However, I believe that part of the difference may be accounted for by a difference in sex, although the abdomen is wanting in one specimen, so it is not possible to be certain of its sex.

I have been unable to find out anything regarding the type of this species. Presumably it was in the collection of the California Academy of Sciences and was destroyed at the time of the San Francisco earthquake and fire, so I have ventured to redescribe it, designating the above specimens as neotypes and placing them in the United States National Museum collection.

BRACON HAEMATODES (Brullé).

Agathis haematodes BRULLÉ, Hist. Nat. Ins. Hym., vol. 4, 1846, p. 495.—CRESSON, Cat. Hym. N. Amer., Suppl. vol., Trans. Amer. Ent. Soc., 1887, p. 227.—VIERECK, Trans. Kansas Acad. Sci., 1905, p. 277.

Agathis meabilis CRESSON, Trans. Amer. Ent. Soc., vol. 4, 1872, p. 183; Cat. Hym. N. Amer., Suppl. vol., Trans. Amer. Ent. Soc., 1887, p. 227.—DALLA TORRE, Cat. Hym., vol. 4, 1898, p. 144.—SZEPLIGETI, Gen. Ins., Fasc. 22, 1904, p. 127.

Cremnops haematodes BRIDWELL, Proc. Kansas Acad. Sci., Dec. 30, 1898, p. 205.

The malar space shorter than the height of the eyes; middle tibiae with two apical spines; hind tibiae with from 2–13 spines clustered above the smaller spur; color red, head more or less black, hind trochanters blackish or darker, at least the hind tarsi and the apices of the hind tibiae black; abdomen often with blackish diffusion over parts of its surface; mesopleural furrow straight; labrum broad; apparently a very variable species; length, 6.5 to 8 mm.

FEMALE.—*Head*.—Triangular, slightly wider than long; typical specimen, length, 54; width, 55; height of eyes, 27; malar space, 25; width between eyes, 30; width at bottom of head, 18; interantennal

plates distinct, separated by a deep groove, face only slightly flattened below the antennae, but rather deeply grooved down this flattened area; ridges above the antennal fossae well developed, usually not strongly arched at any point, although this appears to vary some; highest opposite the median ocellus; continuous to the lateral ocelli; profile of face divided into two slight arches, one from the apex of the clypeus to opposite the clypeal foveae, the second from this point to the antennal pits; the whole head more hairy than in many species, face rather uniformly and fairly closely punctured over its whole surface; compound eyes rather large, dark; ocelli pale, the lateral ocelli slightly nearer to each other than to the median ocellus; antennae black; first two segments shining, rest dull, 37–41 mostly 38 or 40 segmented; head typically pale reddish, approaching orange with at least the cheeks to the clypeal foveae, the vertex in the center, the antennal pits and the occiput in the middle, black or blackish; labrum about as long as wide, blackish or blackish-brown, the lower border paler except the apical rim; mandibles pale, bases, and apices black, rather broad, curved at apex, inner tooth smaller than in many other species; beak black or blackish, head including labrum, varying from entirely pale in immature and faded specimens to almost wholly black, except for the lower portion of the clypeus and a border around the eyes.

Thorax.—Somewhat longer than high, color very variable; propisterna usually more or less black or blackish; sternum pale, blackish or black; tegulae typically blackish-brown with the inner margin pale but varying from entirely pale reddish to black; propodeum always red; pronotal lobes smooth in center, closely and finely punctate and hairy around the borders, shining; apical pits large; propisterna more coarsely and roughly punctured and hairy; the apical lobes more shining, but also punctured; parapsidal furrows fairly deep, nearly straight, distinctly crenulate; median groove of mesonotum usually distinctly and broadly grooved in front, but sometimes more narrowly and obsoletely; lateral lobes somewhat flattened; hind angles of mesoscutum not very much produced; whole surface of mesonotum sparsely and rather finely punctured and hairy; scutellar fossa rather deep, front wall more or less sloping with only the median carina prominent; scutellum triangular, the sides and end rounded off; mesopleurae shining, fairly closely punctate and hairy, the groove deep and coarsely crenulate, terminating abruptly, nearly horizontal or sloping diagonally upward, equal in length to about half the width of the mesopleurae; venter hardly more hairy than the pleurae; metapleurae less shining, more coarsely and closely punctured, the lower third roughened and irregularly areolate; propodeum areolate, with six longitudinal lines, the two median typically converging gradually in front and suddenly behind, the various pairs

united by numerous transverse carinae, but the whole arrangement varying somewhat; spiracles oval or oblong-oval, also variable.

Wings.—Fuliginous, venation typical, light spotting not very noticeable; length, fore 7.1 mm., hind 5.5 mm., of an average specimen.

Legs.—Color typically almost reddish, but actually varying from wholly red, except the tarsal claws, more or less of the trochanters, and the apices of the hind tibiae, to wholly black except for the hind coxae and femora; middle tibiae with two apical spines, hind with from 2–13 apical spines; all tarsal claws apparently cleft, the hind with the two teeth deeply and widely separated.

Abdomen.—Elongate, slender, lanceolate, the first segment rather long dorsally, but also distinctly broadened toward the apex; the second and third tergites together about as long as the first, the division between the two indicated by a faint transverse groove, the second tergite broadly depressed transversely at about the middle; color reddish, with more or less blackish diffusion dorsally; length, 3–4 mm.; ovipositor about as long as the abdomen, reddish, the sheaths black.

MALE.—The male appears to resemble the female closely, showing the same variability of color and structure.

Redescribed from 31 specimens.

The specimens included under this species name appear to group themselves into three lots on the basis of the number of apical spines on the hind tibiae, although the groups do not seem to possess any other characters in common. The distribution of the species with the specimens arranged thus is as follows:

With 2–3 apical spines: 4 females and 3 males from various parts of Texas; 2 females and 2 males from "Ga."; 1 female from Alexandria, Louisiana, July 30; 2 females from Malcolm, Nebraska, October 12 and 24; 2 females from "Ainsworth, W. T., July 20/82"; 1 female, No. 2364, Hubbard's No. 98; 2 males, "Miss."

With 5–7 apical spines: 1 female, Austin, Texas, September 26; 1 female Victoria, Texas, July 15, on alfalfa; 1 female, Alexandria, Louisiana, July 30, on cotton; 1 male, Corpus Christi, Texas, October 16; 1 male, Brownsville, Texas, September 29; 1 male, San Antonio Texas; 1 female, Onaga, Kansas; 1 female, "Ill."

With 9–13 apical spines: 2 females, Mission, Texas, May 13, bred from "Lep."; 1 male, "Colo. 1569"; 1 male, Victoria, Texas, July 28.

This is by far the most variable American species in the genus *Bracon*, and I am still a little undecided as to whether some of the specimens included here should be considered as properly placed. I have not been able to find any definite characters or sets of characters which would serve to distinguish the more widely varying specimens from those which are typical. There is no question but that

Cresson's *meabilis* is included here, as I have examined the types, and some of the specimens fit very closely Brullé's descriptions of *Agathis haematodes*, so I have used this name for the species.

I do not know the location of the type of *Agathis haematodes* Brullé, which was described from a single male from Philadelphia. The types of *Agathis meabilis* Cresson are in the collection of the Academy of Natural Sciences of Philadelphia.

***BRACON VIRGINIENSIS*, new species.**

Plate 27, fig. 19.

Agathis haematodes Br. (*Cremnops*) SMITH, List of the Insects of New Jersey, 1909, p. 609.

Cremnops haematodes BANKS, Ent. News, vol. 23, 1912, p. 108.

Malar space shorter than the height of the eyes; body, including mouth parts, wholly pale red, except the antennae and eyes, tarsal claws, hind tarsi, and tips of hind tibiae; abdomen sometimes with blackish diffusion above; hind tibiae with two apical spines; first abdominal segment very long and slender; length, 8 mm.

FEMALE.—*Head.*—Triangular, wider than high; length, 55; width, 61; height of eyes, 30; malar space, 24; width between eyes, 33; width at bottom of head, 18; interantennal plates distinct, rather widely separated by a rather flat groove with rounded bottom; face hardly flattened below the antennae, broadly and shallowly grooved for about one-third of its length below the antennae; profile nearly straight, very slightly and irregularly arched, faintly depressed opposite the clypeal foveae; ridges surrounding the antennal fossae prominent, highest opposite the upper margin of the median ocellus, continuous to the lateral ocelli; head, including the mouth parts, wholly red, except for the compound eyes, which are dark, and the antennae, which are blackish; face shining, rather densely punctate and hairy below the antennae, more sparsely and faintly so below on the clypeus and on the cheeks; compound eyes relatively large, dark; ocelli light, approximately equidistant from one another; antennae black or blackish-brown in some lighter specimens, 40–41 segmented, first two segments shining, the rest dull; labrum slightly wider than long, pale, the apical raised rim darker, and nearly straight for a short distance, shining, sparsely and finely punctate and hairy; mandibles pale, tips blackish; beak wholly pale, the second segment of both the maxillary and labial palpi the largest and longest, the last segment of each elongate, slender, nearly cylindrical.

Thorax.—Longer than high, wholly red; lateral lobes of pronotum smooth, shining, finely, and densely punctate around the margins, the apical pits deep but short; proepisterna more coarsely punctured and hairy, the apical lobes smooth and shining; mesonotum shining, sparsely punctured and hairy; parapsidal furrows distinct, not very

deep, rather finely crenulate, converging behind, meeting before the scutellar fossa, and not continued to this fossa as a distinct groove; median lobe distinctly flat grooved medially, at least in front, lateral lobes slightly flattened in the middle of the disk of each; hind angles of the mesoscutum produced into broadly rounded, vertically compressed lobes; scutellar fossa rather shallow as compared with other species, the bottom concave, the front wall sloping strongly forward, with a single prominent longitudinal carina bisecting it; scutellum relatively broad and short, sides rounded off, not tapering strongly behind, apex bluntly rounded; mesopleurae sparsely punctured and hairy over the whole of their surface, more densely so below and on the venter; mesopleural furrow shallow, deeper behind and fading out completely in front, about as long as half the width of the pleurae, running diagonally upward; metapleurae shining, sparsely and rather coarsely punctured, only the lower border roughened and with ridges; propodeum coarsely areolate, the median ridges most widely separated behind, coming gradually to meet each other in front; spiracles oval.

Wings.—Length, fore, 7 mm., hind 5.5 mm.; fuliginous, venation and light spotting typical.

Legs.—Entirely red, except all the tarsal claws, the apices of the hind tibiae, and all the hind tarsi and the extreme base of the metatarsus; hind tibiae with 2 stout spines at the apex just above the smaller apical tibial spur; middle tibiae usually with 1, often with 2 apical spines.

Abdomen.—Length about 4 mm., elongate, slender, lanceolate, the first segment relatively very long, and only slightly widened toward the apex; the tergite of segments two and three also very long, these three segments occupying almost four-fifths of the length of the abdomen, the division between the second and third segments indicated dorsally by an indistinct flat groove; color wholly red, but sometimes with blackish diffusion either near the middle or apically; ovipositor red, the sheaths black, length about 3.5 mm.

MALE.—Apparently resembles the female in all essential structural characters as well as in coloration; first three segments of the abdomen not occupying more than two-thirds of its total length.

Described from 12 female specimens from Falls Church, Virginia, June and July (3), Great Falls, Virginia, June 27 (1), Washington, District of Columbia, June 20 (1), Westville, New Jersey, August 30 (1), and 1 each from "N. Y.," "Miss.," and "N. C.," while three specimens have no data accompanying them, and 9 male specimens from "Falls Church, Va., July and Aug." (3), Philadelphia, Pennsylvania; (1), Glenside, Pennsylvania, June 8 (1), Wallace, Kansas, July (1), Lexington, Kentucky, (1), "L. I." (1), and a bred specimen without host or locality record.

This species is labeled "*Cremnops haematodes* Brullé" in the Philadelphia Academy of Natural Sciences collection and in the United States National Museum material, and probably in other collections also, but a cursory examination of Brullé's description will show that this identification is not correct.

Type.—Cat. No. 20484, U.S.N.M.

EXPLANATION OF PLATES.

PLATE 24.

FIG. 1a. Fore and hind wings of *Bracon vulgaris*, showing the cells named according to the usual nomenclature: *a*, anal; *ap*, apical; *ar*, areolet (second cubital); *cu*₁ first cubital; *cu*₂ third cubital; *d*, discoidal; *d*₁ first discoidal; *d*₂ second discoidal; *d*₃ third discoidal; *m*, median; *r*, radial; *sm*, submedian.

1b and 1c. Fore and hind wings of *Bracon vulgaris*, showing the veins named according to the usual nomenclature: *a*, anal; *b*, basal; *c*, costal; *cu*, cubital; *d*, discoidal; *f*, fold; *m*, median; *r*, radial; *re*, recurrent; *s*, stigma; *sd*, subdiscoidal; *tc*, transverse cubital; *tc*₁ first transverse cubital; *tc*₂ second transverse cubital; *tm*, transverse median (nervulus).

PLATE 25.

FIG. 2. Head of *Bracon vulgaris* from the front.

3. Head of *Bracon vulgaris* from above.

4. Beak of *Bracon vulgaris* from behind.

5. Head of *Bracon vulgaris* from the side and behind.

6. Profile of metanotum and propodeum of *Bracon slossonae*.

7. Profile of metanotum and propodeum of *Bracon vulgaris*.

PLATE 26.

FIG. 8. Thorax of *Bracon vulgaris* from the side: *A*, abdomen; *C*₁, fore coxa; *C*₂, middle coxa; *C*₃, hind coxa; *E*₁, proepisternum *h*, parapeidal furrow; *I*, propodeum; *N*₁, pronotum; *N*₂, metanotum; *p*₂, prescutum of mesothorax; *P*₂, mesopleura; *P*₃, metapleura; *S*₂, scutum of mesothorax; *Sc* and *Sc*₂, scutellum (of mesothorax); *sp*, spiracle; *St*₂, sternum of mesothorax; *T*, tegula.

9. Thorax of *Bracon vulgaris* from above. Lettering as figure 8.

10. Abdomen of *Bracon vulgaris*, female from the side.

11. Male genitalia of *Bracon vulgaris* from the side.

12. Ventral segments of abdomen of male of *Bracon vulgaris*.

PLATE 27.

FIG. 13. Prothorax of *Bracon slossonae* from the side, showing groove.

14. Prothorax of *Bracon slossonae* from above.

15. Prothorax of *Bracon vulgaris* from the side, showing pits.

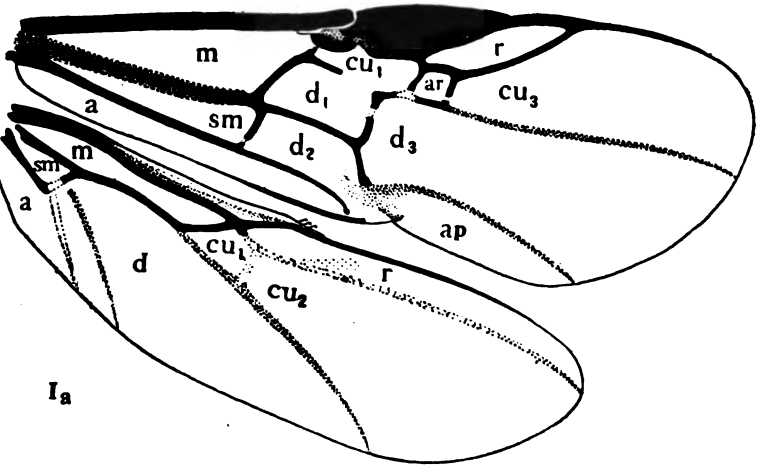
16. Prothorax of *Bracon vulgaris* from above.

17. Fore tarsal claws of *Bracon vulgaris*.

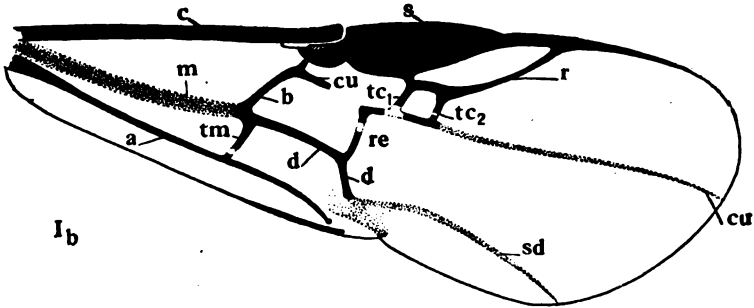
18. Hind tarsal claws of *Bracon vulgaris*.

19. Apex of hind tibia of *Bracon virginensis*, showing spines.

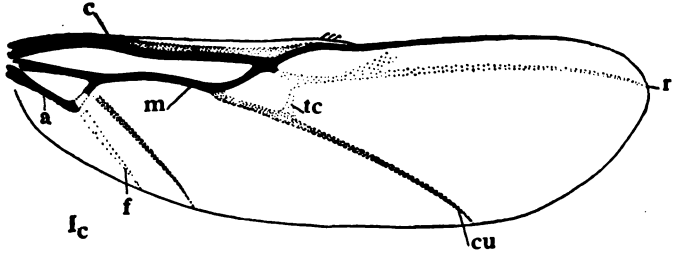
20. Apex of hind tibia of *Bracon vulgaris*, showing spines.



Ia

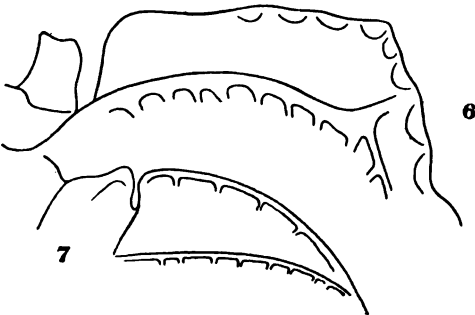
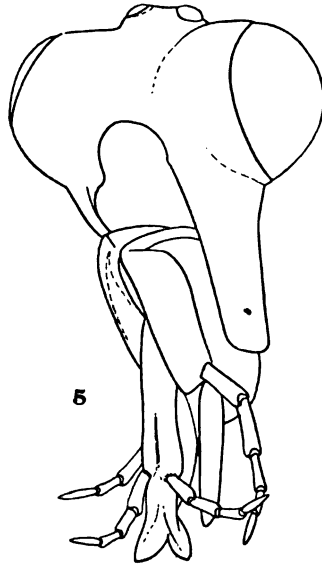
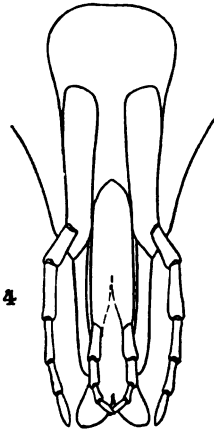
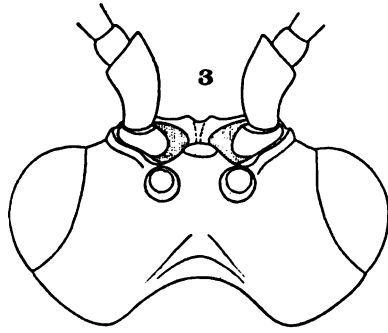
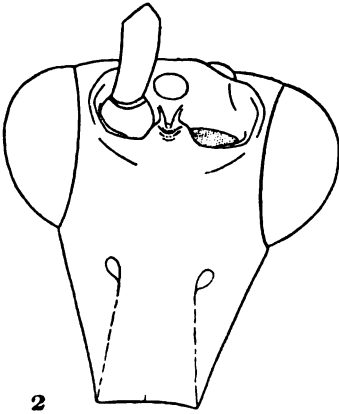


Ib



Ic

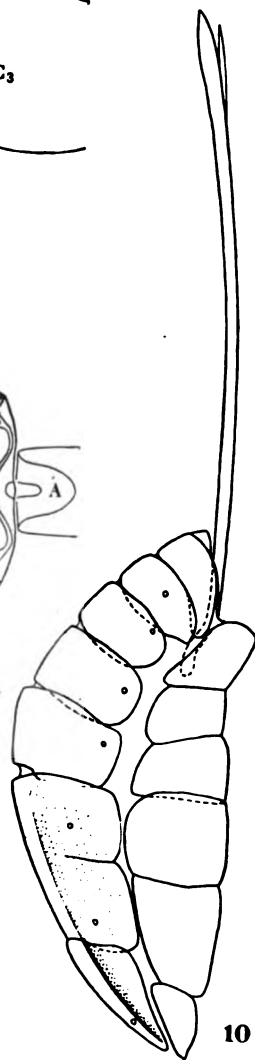
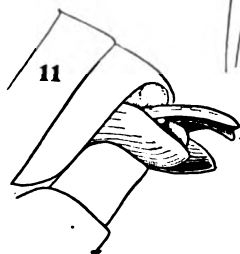
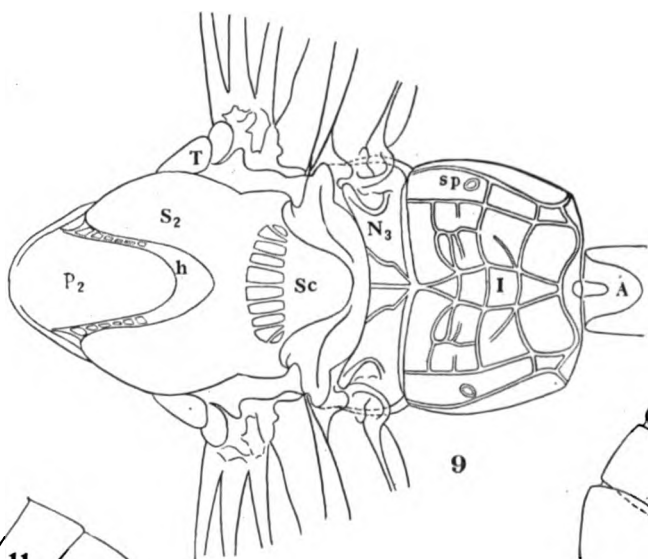
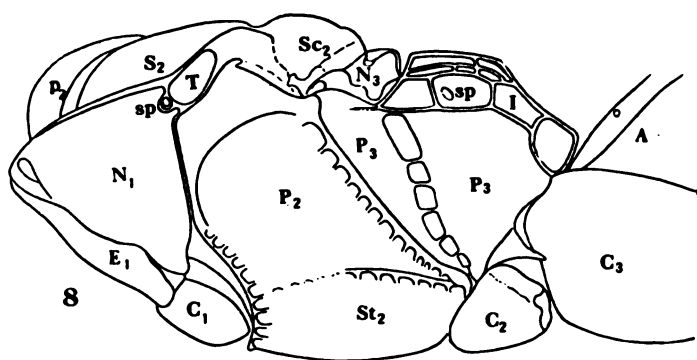
MORPHOLOGY OF BRACON.
FOR EXPLANATION OF PLATE SEE PAGE 343.



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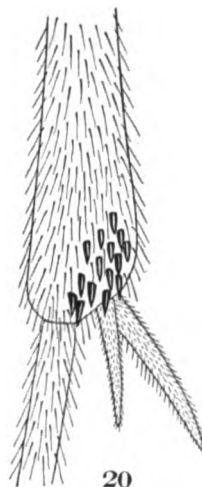
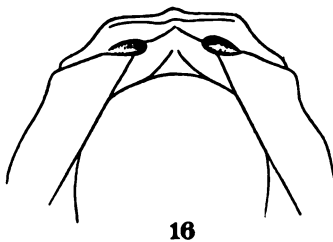
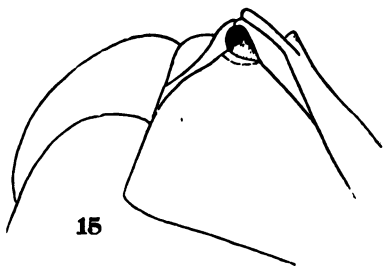
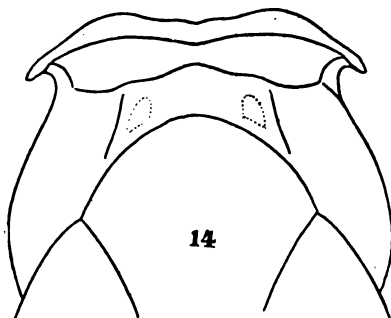
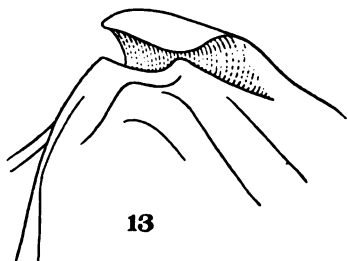
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MORPHOLOGY OF BRACON.

FOR EXPLANATION OF PLATE SEE PAGE 343.

THE VARIATION EXHIBITED BY THAMNOPHIS ORDINOIDES (BAIRD AND GIRARD), A GARTER SNAKE INHABITING THE SAN FRANCISCO PENINSULA.

By JOSEPH C. THOMPSON,
Surgeon, United States Navy.

INTRODUCTION.

The more one reviews the literature of the garter snakes of North America, the more one becomes impressed with the necessity of ascertaining the complete range of variation that may be exhibited by each of the well-established species in the genus. To determine this it will be requisite to collect a fair series of specimens from a restricted locality and to record its slightest variations. Similar studies will have to be made of sets from widely separated regions. In order to facilitate the comparison of the data an endeavor should be made to conform to a uniform method of tabulating the figures and presenting the facts.

In the past *T. ordinoides* has been divided into as many as eight species and subspecies; this alone implies that the form is subject to considerable variation. What this variation really amounts to can only be appreciated by one who has seen large series from all parts of its range, for it is difficult to believe that the dwarfed and sombre-hued examples from the north, with the minimum scale count of 17-15, are one and the same species as the large brilliantly colored specimens from the south or the veritable giant from the Santa Clara Valley, whose body alone measures 1,040 mm. and has a maximum scale formula of 21-23-21-19-17.

Dr. Ruthven in his Memoir on the Garter Snakes of North America¹ recognizes *Thamnophis elegans* (Baird and Girard) 1853, and *Thamnophis ordinoides* (Baird and Girard) 1852, as distinct species. In speaking of *T. elegans*² he writes: ". . . its western limit can not be drawn exactly owing to the fact that it intergrades with another form . . ." referring to *T. ordinoides*. In speaking of

¹ 1908, Bull. 61, U. S. National Museum.

² *Idem*, p. 143.

*T. ordinoides*¹ he states: "I believe that it is impossible to fix the exact eastern and southern boundary of *ordinoides* for the reason that it intergrades with *elegans* throughout the entire length of its range." From this two inferences may be drawn: These species are either valid and the specimens are amenable to unquestionable separation, or our recognition of them as two distinct forms must give way to the fact that there is complete intergradation, hence they are not distinct and require to be united.

The initial step in the direction of attempting to ascertain the final status of these two species was taken when 50 specimens of *T. ordinoides* from the Sausalito Peninsula were subjected to a critical examination.² The present contribution offers the data obtained from a similar number of specimens captured in Golden Gate Park on the San Francisco peninsula along with a comparison of the two series. As a further illustration of the need of these and similar studies there is appended the record of 80 specimens from twelve different localities.

METHODS.

In order that the data be correctly coordinated it is necessary to ascertain the highest scale row count that obtains in the genus. In *Thamnophis* the maximum is 23 rows. The paired rows are designated by permanent numbers from I to XI and the median by M, the count being made from without inward.

When the number of scale rows is decreased the sequence of suppression is constant and is as follows:

- 23 rows, V row suppressed, leaving,
- 21 rows, VI row suppressed, leaving,
- 19 rows, IV row suppressed, leaving,
- 17 rows, VII row suppressed, leaving,
- 15 rows, which are continued to the vent.

In dealing with a specimen in which the maximum count is 21 rows it is necessary to regard the V row as suppressed constructively. In enumerating the rows one must count I, II, III, IV (V suppressed), VI, VII, VIII, IX, X, XI, and the median. In such a specimen when the 21 rows are reduced posteriorly to 19 rows it will be found to be due to the termination of the fifth row in actual counting, but this row in terms of the generic count is the VI row and must be so recorded. When the 19 rows are decreased to 17 it is due to the ending of the fourth row in actual counting, which is also the IV row in the generic sense. When the 17 rows are reduced to 15 it is due to the loss of the fourth row in actual counting, which in this case is the VII row in terms of the generic count. Constant attention to these details is imperative.

¹ 1906, Bull. 61, U. S. National Museum, p. 149.

² 1914, Thompson, Proc. U. S. Nat. Mus., vol. 47, pp. 351-360.

VARIATION IN NUMBER OF DORSAL SCALE ROWS.

This species presents the widest range of variation in the number of scale rows that is to be found in the group. There are at present known in the genus eleven distinct scale formulae, ten of which have been recorded in *T. ordinoides*. These ten and the frequency of occurrence of the five combinations found in the San Francisco series are as follows:

	Per cent.		Per cent.
21-23-21-19-17	0	19-17-15-13.....	0
21-19-17.....	12	17-19-17-15.....	0
19-21-19-17.....	56	17-15.....	0
19-21-19-17-15.....	8	15-17-15.....	0
19-17.....	16	Asymmetrical.....	4
19-17-15.....	4		

The influence of sex upon the variations in this character is clearly demonstrated. Among the specimens that vary from what may be assumed to be the normal count of 19-21-19-17, those having the lower counts are prone to be males, and those with the higher counts are largely females. This increase in the number of scale rows in the female is associated with the need for the increase in the diameter of the abdominal cavity when carrying the young.

	Males.	Females.
	Per cent.	Per cent.
21-19-17	17	83
19-21-19-17.....	39	61
19-21-19-17-15	50	50
19-17.....	86	14
19-17-15	67	33

The data showing the gastrostegs levels on the right and left side of the body at which the added rows begin and the suppressed rows end may be learned from the following tables:

SCALE FORMULA 21-19-17.

This is next to the highest count recorded in the species. In this series it occurs in 12 per cent of the specimens of which 16 per cent are males.

U.S.N.M. No.	Sex.	Ventrals.	Scale rows.		
			21-VI.	19-IV.	17 cont.
52176.....	Male	158	68 76	92 92	.....
53575.....	Female..	151	71, IV 74	98, VI 99	.....
52190.....	..do.....	153	70 70	92 95	.....
52159.....	..do.....	155	71 76	89 88	.....
53545.....	..do.....	155	65, IV 71	82, VI 87	.....
53577.....	..do.....	157	71 73	99 101	.....

SCALE FORMULA 19-21-19-17.

This formula may be regarded as the normal for this immediate region. It is found in 56 per cent of the specimens; of these, 39 per cent are males.

MALE.

U.S.N.M. No.	Ventrals.	Scale rows.			
		19+VI.	21-VI.	19-IV.	17 cont.
52184.....	154	26 28	51 42	77 76	.....
53583.....	157	32 30	51 58	78 78	.....
52163.....	158	47 41	53 43	79 80	.....
53573.....	158	27 25	60 65	83 86	.....
52179.....	159	24 27	68 74	89 89	.....
52180.....	159	24 37	60 60	86 86	.....
52166.....	160	26 24	70 70	86 87	.....
52174.....	160	27 24	62 63	82 83	.....
53581.....	161	34 26	44 32	87 82	.....
52181.....	162	32 32	69 62	86 86	.....
52162.....	162	30 31	71 75	92 93	.....

FEMALE.

The influence of sex on this character is evident. On the average the VI row tends to be longer in that it begins further forward and extends more to the rear. The IV row also ends further back. This lengthening of the scale rows is associated with the stouter body in the female.

U.S.N.M. No.	Ventrals.	Scale rows.			
		19+VI.	21-VI.	19-IV.	17 cont.
52170.....	147	32 32	50 50	76 76	.....
53541.....	149	23 22	60 61	87 86	.....
52161.....	150	32 44	55 53	82 82	.....
52175.....	150	24 23	61 62	80 82	.....
52171.....	151	31 36	40 55	79 79	.....
52160.....	152	13 13	68 71	90 93	.....
52168.....	153	26 26	58 58	83 84	.....
52165.....	153	30 41	51 51	81 79	.....
53576.....	153	22 23	68 67	88 90	.....
53542.....	153	26 28	54 53	82 86	.....
53585.....	154	24 24	65 68	88 92	.....
52167.....	155	29 27	64 65	89 87	.....
52164.....	155	22 20	62 64	85 92	.....
52185.....	156	21 13	68 71	91 95	.....
52158.....	157	27 23	63 71	89 88	.....
52178.....	160	27 26	67 59	88 89	.....
52186.....	166	12 15	75 75	91 92	.....

It will be noted that No. 52170 is bilaterally symmetrical. It is comparatively rare for the scale rows to arise and to be suppressed at exactly the same gastrostegic levels.

SCALE FORMULA 19—21—19—17—15.

This is not a common variation. It occurs in 8 per cent of the series, and of these 50 per cent are males. In specimens with this formula there are five zones on the body, each with a different count. In two examples the VII rows reappeared just anterior to the vent, thereby increasing the count to 17 in this zone.

U.S.N.M. No.	Sex.	Ventrals.	Scale rows.				
			19+VI.	21—VI.	19—IV.	17—VII.	15 cont.
52182....	Male.....	156	30 30	54 51	77 77	121 124	.....
52173....	do.....	156	30 28	51 62	84 86	122 129	.....
53580....	Female..	158	28 35	49 50	83 81	130 141	.....
52172....	do.....	151	31 43	57 52	81 79	135 135	.....

SCALE FORMULA 19—17.

This formula is found next in frequency to the normal. It occurs in 14 per cent of the series, and of these 86 per cent are males. Two specimens in this table exhibited bilateral symmetry, the rows terminating on each side at exactly the same level.

U.S.N.M. No.	Sex.	Ventrals.	Scale rows.	
			19—IV.	17 cont.
52169.....	Male.....	152	75 75	.....
53578.....	do.....	156	81 81	.....
53579.....	do.....	157	80 80	.....
53584.....	do.....	159	78 80	.....
53543.....	do.....	159	78 79	.....
53544.....	do.....	159	81 82	.....
52187.....	Female....	152	83 83	.....

SCALE FORMULA 19—17—15.

This is the least frequent count in the series. It occurs in but 6 per cent, of which 66 per cent are males.

In both these specimens the VII rows reappear a short distance anterior to the vent.

U.S.N.M. No.	Sex.	Ventrals.	Scale rows.		
			19—IV.	17—VII.	15 cont.
52177.....	Male.....	153	77 78	135 138	.....
53582.....	do.....	156	74 76	112 118	.....
52188.....	Female....	156	78 79	135 137	.....

BILATERALLY ASYMMETRICAL.

U.S.N.M. No.	Sex.	Ventrals.	Scale rows.			
			19+VI.	21-VI.	19-IV.	17 cont.
52183.....	Male.....	158	<i>rt. Lt.</i> 33	<i>rt. It.</i> 51	81 82	.....
52189.....	Female....	159	{28 41	{34 43	} 87 87	.....

It will be noted that in both these cases the asymmetry consists in an absence of the VI row on the left side of the body. It is this row that is normally added to the 19 row zone anteriorly and raises the count to 21 rows. In the male the VI row exists on the right side between the level of the thirty-third and the fifty-first gastrostege. In the female this row is also present only on the right side; it differs in being interrupted, one series extending from the twenty-eighth to the thirty-fourth, and the other from the forty-first to the forty-third gastrostege.

There is one important question bearing on these dermal characters that requires to be settled, and that is whether the number and extent of the scale rows are definitely fixed from birth and remain the same throughout the life of the individual, or if their number and extent may be increased as a sequel to abundant food, corpulency, pregnancy, and old age. The fact seems to be, that when a series of these garter snakes from the same locality is examined, a suspiciously large percentage of the low-scale row counts are found in the young and half-grown examples.

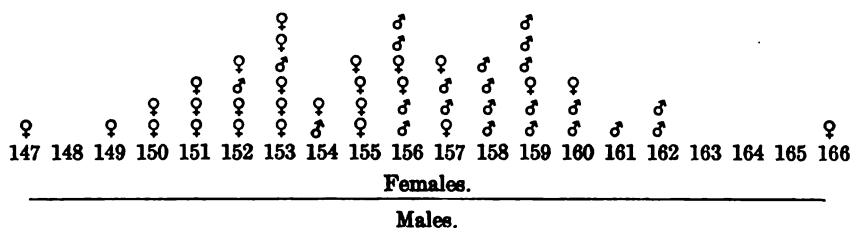
OTHER VARIATIONS.

All of the dermal characters show more or less variation. The scale rows in the zones of transition from the neck to the body and between the body and the tail are too irregular and complicated to permit the making of satisfactory records. There is some variation in the size and shape of the rostral, frontal, and parietal shields that depends upon the age of the specimen. The numerical variations in other characters are very important to ascertain, for they confirm beyond dispute, as Doctor Ruthven has demonstrated, the genetic relationships among the species.

VARIATION IN GASTROSTEGES.

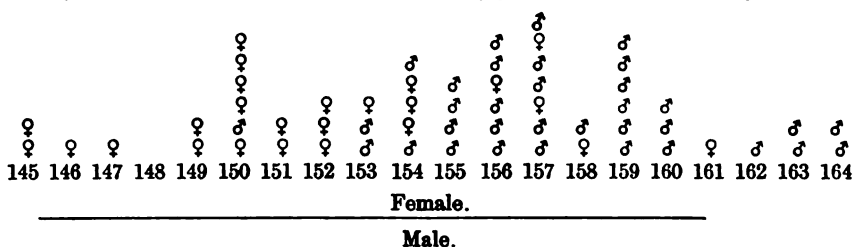
Attention is drawn to the fact that the minimum and maximum counts have been found in the female specimens. In the males the range of variation is but 55 per cent of the total and centers nearly around the mean for the series.

Diagram showing the variation in the number of gastrosteges in specimens from San Francisco.



Range of variation in 50 specimens.....	147-166
Males, 23 specimens.....	152-162
Females, 27 specimens.....	147-166

Diagram showing the variation in the number of gastrosteges in Sausalito specimens.



Range of variations in 59 specimens.....	145-164
Males, 34 specimens.....	150-164
Female, 25 specimens.....	145-161

An occasional specimen is seen in which some of the gastrosteges are incomplete in that they fail to reach across the body. These incomplete shields usually extend nearly to the median line. Where there are several on one side the asymmetry is often compensated for by there being nearly an equal number on the opposite half of the body.

One specimen, a female, from San Francisco, Cat. No. 53574, U.S.N.M. (Orig. No. T-136), that is not included in the series, has nine incomplete gastrosteges on the right and none on the left side of the body. It is further abnormal in having a low gastrostege count of 149 (right), a scale formula of 21—19—17—15, and eight infralabial shields on the left side.

VARIATION IN ANAL.

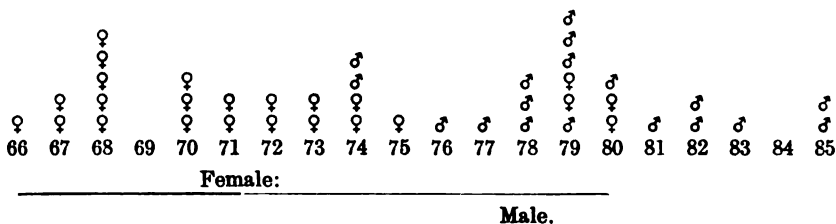
The normal condition is for this shield to be entire. There are no specimens in this series in which it is divided.

VARIATION IN UROSTEGES.

These plates are normally paired. An occasional specimen may be found in which from one to two of the urosteges remain entire. When this occurs, these undivided shields are regularly situated near the base of the tail. All showing this variation are males.

Paired throughout, 94 per cent; 1 to 2 entire, 6 per cent.

Diagram showing the variation in the number of urosteges in specimens from San Francisco.



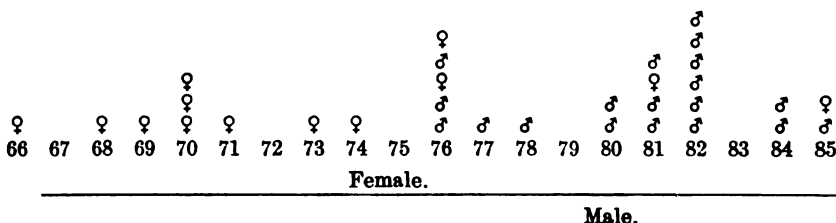
Range of variation in 42 specimens:

Males, 18 specimens 74—85

Females, 24 specimens 66—80

Further along when the table comparing these specimens with the series from Sausalito is reviewed; it will be noted that in both localities the range in the number of urosteges is from 66 to 85. These bare figures fail to bring out one salient feature—the higher average that exists in the Sausalito set. This difference may be seen at a glance if the preceding and following diagrams be compared.

Diagram showing the variation in the number of urosteges in specimens from Sausalito.



Range of variation in 32 specimens:

Males, 19 specimens 76—85

Females, 13 specimens 66—85

Over one-half of these from Sausalito have the tail docked, while less than one-fifth of the snakes from Golden Gate Park are similarly crippled. In grazing land this is frequently due to their being trodden upon by cattle. Where field rodents are plentiful the tail is often bitten off and devoured by these animals.

VARIATION IN PREOCULAR.

The normal condition is a single preocular. Where two exist it is due to the fragmentation of the lower one-third of the normal shield. Where three are found it is due to a middle plate which has become separated from the anterior superior shield. In the majority of specimens the lower portion of the preocular is of a lighter tint and frequently is indented at the margins. In the specimens showing variation in this character 25 per cent are males.

	Per cent.
1 normal.....	92
1-2 asymmetrical.....	4
2 bilateral.....	2
2-3 asymmetrical.....	2

VARIATION IN POSTOCULARS.

In this series the variation in the postocular shields is limited, much more so than in the Sausalito specimens. When the number is reduced to two it is due to the fusing of the normal middle and inferior shields; when increased to four it is due to the dividing of the inferior shield. In the specimens showing variation in this character 50 per cent are males.

	Per cent.
3 normal.....	98
3-2 asymmetrical.....	2
3-4 asymmetrical.....	2

VARIATION IN ANTERIOR TEMPORAL.

This shield is subject to but slight variation. When there are two it is due to a separation of the antero-external angle of the parietal. This part of the parietal is at times dented or partially incised. The single specimen showing an aberration in this character was a male.

	Per cent.
1 normal.....	98
1-2 asymmetrical.....	2

VARIATION IN POSTERIOR TEMPORALS.

These shields exhibit considerable irregularity as to shape and size. Their number may be increased to three; very rarely they become fused into one. The abnormal specimens were all females.

	Per cent.
2 normal.....	92
2-3 asymmetrical.....	4
3 bilateral.....	4

VARIATION IN SUPRALABIALS.

The normal is 8 supralabials with the fourth and fifth bordering the orbit. When the number is reduced to 7 it is due to the fusing of the normal second and third shields (66 per cent), or the sixth and seventh shields (33 per cent). None of the specimens in this set showed the increase to 9 supralabials which is known to occur at times in this species. In the specimens showing variation in this character 20 per cent are males.

	Per cent.
8 normal.....	90
8-7 asymmetrical.....	10

VARIATION IN INFRALABIALS.

The normal count is 10 infralabials. When the number is decreased to 9 it is due to the fusing of the normal third and fourth shields (82 per cent), or the normal seventh and eighth (18 per cent). When the number is further reduced to 8 it is due to the fusing of these same pairs—namely, the third and fourth and the seventh and

eighth. None in this set showed the increase to 11 infralabials which is known to occur in specimens from this part of the State. Among the specimens showing variation in this character 27 per cent are males.

	Per cent.
10 normal.....	78
10-9 asymmetrical.....	14
9 symmetrical.....	2
9-8 asymmetrical.....	4
8 symmetrical.....	2

One specimen, Cat No. 53574, U.S.N.M. (Orig. No. T-136), a female, shows marked asymmetry, there being 10 shields on one and 8 shields on the other side. This is the specimen in which many of the gastrosteges are incomplete.

VARIATION IN GENEIALS.

The anterior and the posterior pairs may be equal in length, one pair may be longer or shorter than the other, and it often occurs that there is much discrepancy between the length of the right and left posterior shields. In spite of these facts, this purely book character—the relative length of the anterior in terms of the posterior pair of geneials—has been made use of in the attempt to separate this complex Pacific Coast garter snake into endless species.

VARIATION IN GULARS.

The gular shields that lie between the posterior geneials and the first gastrosteges are irregularly paired anteriorly and azygos posteriorly. The normal count is two paired and two unpaired shields. The variation ranges from four paired and one unpaired to one unpaired and four azygos shields.

SUMMARY OF VARIATIONS.

The following may be assumed to be the normal conditions:

	Per cent.
Scale rows, 19-21-19-17.....	56
Preocular, 1.....	90
Postoculars, 3.....	96
Anterior temporal, 1.....	98
Posterior temporals, 2.....	92
Supralabials, 8.....	90
Infralabials, 10.....	78
Anal, entire.....	100
Urosteges, paired.....	94

The following table shows the percentage of normal individuals and the percentage of those that are abnormal in one or more characters:

	Per cent.
Normal in all characters.....	38
Abnormal in one character.....	30
Abnormal in two characters.....	22
Abnormal in three characters.....	8
Abnormal in four characters.....	2

Tabulated summary.

U.S.N.M. No.	Sex.	Scales.	Oculars.		Temporals.		Labials.		Gast.	An.	Urost.
			Pre.	Post.	Ant.	Post.	Supra.	Infra.			
52176	Male	21-19-17							158		81
52190	Female	21-19-17				3			153		74
52159	do.	21-19-17	2					9-10	155		?
53575	do.	21-19-17				3			151		73
53577	do.	21-19-17							157		68
53545	do.	21-19-17		3-4					155		75
52184	Male	19-21-19-17							154		78
52163	do.	19-21-19-17							158		?
52179	do.	19-21-19-17							159		76 (III)
52180	do.	19-21-19-17							159		78
52166	do.	19-21-19-17							160		79
52174	do.	19-21-19-17							160		78
52181	do.	19-21-19-17						10-9	162		? (II-IV)
52162	do.	19-21-19-17							162		?
53573	do.	19-21-19-17							158		?
53583	do.	19-21-19-17						9	157		77
53581	do.	19-21-19-17							161		82
52170	Female	19-21-19-17				3-2			147		66
52161	do.	19-21-19-17							150		?
52175	do.	19-21-19-17							150		70
52171	do.	19-21-19-17							151		67
52160	do.	19-21-19-17	2-3		2-1				152		74
52168	do.	19-21-19-17							153		?
52165	do.	19-21-19-17						10-9	153		70
52167	do.	19-21-19-17	2-1						155		68
52164	do.	19-21-19-17							155		67
52185	do.	19-21-19-17							156		72
52158	do.	19-21-19-17							157		?
52178	do.	19-21-19-17							160		71
52186	do.	19-21-19-17							166		74
53576	do.	19-21-19-17							153		71
53585	do.	19-21-19-17				3-2		9-10	154		68
53541	do.	19-21-19-17							149		68
53542	do.	19-21-19-17		4-3					153		68
52182	Male	19-21-19-17-15					7-8		156		85
52173	do.	19-21-19-17-15							156		82
52172	Female	19-21-19-17-15							152		72
53580	do.	19-21-19-17-15							151		70
52169	Male	19-17					8-7	10-9	152		74
53584	do.	19-17						9-8	159		70
53579	do.	19-17	1-2				7-8	8-9	157		79
53543	do.	19-17							159		80
53544	do.	19-17		3-2				9-10	159		74
53578	do.	19-17							156		79 (III)
52187	Female	19-17							152		80
52177	Male	19-17-15						9-10	153		83
53582	do.	19-17-15					8-7	8	156		85
52188	Female	19-17-15							156		79
52183	Male	Asymmetrical							158		80
52189	Female	Asymmetrical					8-7		159		79

For the sake of clearness the normal records are indicated by dashes.

This table brings to light an interesting condition: Specimens that have the normal scale row count of 19-21-19-17 are prone to be normal in the remaining characters in that only 33 per cent of them present any variations; on the other hand, in those having an abnormal scale row count 66 per cent, possess other variations from the normal. This is an analogous condition to that shown in the study of degenerates among the human species. Individuals are much more liable to have several stigmata than but a single earmark of faulty heredity.

INFLUENCE OF SEX ON VARIATION.

In zoology it is a fairly well established point that in a given species the range of variation is regularly greater in a series of males than in a series of female specimens. In the anthropoid apes and in the

human species this is particularly noticeable, the female remaining nearer the infantile and generalized type than the male.

When the influence of sex is examined for *T. ordinoides*, it is found that the opposite condition prevails. The following list shows that a greater number of variations occur among the female specimens:

	Male.	Female.
Abnormal as to—	<i>Per cent.</i>	<i>Per cent.</i>
Scale rows.....	45	55
Preocular.....	25	75
Post ocular.....	33	67
Anterior temporal.....	100	0
Posterior temporal.....	0	100
Supralabials.....	20	80
Infralabials.....	27	73

VARIATION IN COLOR.

In the young the ground color is almost invariably a dark olive; the dorsal and lateral rows of spots are large, regular, and sharply defined; the median stripe is pale yellow; the underside is greenish grey; no specimens are seen with even a trace of red.

In the adults the ground color varies in different examples, there being many hues of dull brick red, olive brown, and dark olive; the dorsal and lateral spots are clearly marked, in some the dorsal series is partly fused; the median stripe is sharply defined, varying from pale yellow to dark orange, and when of the latter color it is at times dotted with salmon; the lateral stripe is yellowish or greenish grey, in some this line is also dotted with salmon; the underside is usually a uniform bluish or greenish grey, and in a few specimens there are a few irregular reddish spots.

The most striking chromatic character in this set is the absence of any examples having the striped pattern, those in which the ground color is a solid dark brown, without spots or red, and with the median and lateral stripes bright and sharply defined. In having but the one color pattern this set from Golden Gate Park is distinctive. Series from over a score of different localities have been studied and each set regularly contained from two to three separate designs.

FOOD.

The food was found to consist almost entirely of slugs, of the family *Arionidae*. Two of the largest snakes had eaten small rodents, and several had remains of salamanders, *Batrachoseps*, and *Austodax* in the stomach.

The garden slugs in and about San Francisco are abundant and are most destructive to small and tender cultivated plants. As the Bay Region has not proved favorable for the establishing of toad colonies,

the garter snakes assume a rôle of particular economic interest. They should become a special object of care and protection on the part of florists and gardeners.

COMPARISON BETWEEN SAN FRANCISCO AND SAUSALITO SERIES.

There is presented for comparison in the following parallel columns a summary of the variations in the series from the two localities on either side of the Golden Gate:

	San Francisco.	Sausalito.
Scale rows:	<i>Per cent.</i>	<i>Per cent.</i>
21—23—21—19—17		
21—19—17	12	6
19—21—19—17	58	66
19—21—19—17—15	8	
19—17	14	10
19—17—15	6	12
19—17—15—13		
17—19—17—15		
17—15		
15—17—15		
Asymmetrical	4	4
Preocular:		
1 normal	92	86
1-2 asymmetrical	4	10
2 bilateral	2	4
2-3 asymmetrical	2	
Postoculars:		
3 normal	94	80
3-2 asymmetrical	2	10
3-4 asymmetrical	4	6
2 bilateral		2
4 bilateral		2
Anterior temporal:		
1 normal	98	94
1-2 asymmetrical	2	4
2 bilateral		2
Posterior temporals:		
2 normal	92	82
2-3 symmetrical	4	12
3 bilateral	4	6
Supralabials:		
8 normal	90	94
8-7 asymmetrical	10	4
8-9 asymmetrical		2
Infralabials:		
10 normal	78	74
10-11 asymmetrical		6
10-9 asymmetrical	14	10
10-8 asymmetrical		2
9 bilateral	2	4
9-8 asymmetrical	4	4
8 bilateral	2	
Anal:		
Entire normal	100	90
Divided		10
Urosteges:		
Paired normal	94	72
1 to 4 entire	6	23
Gastrosteges (plates)	147-166	145-164
Urosteges (plates)	66-85	66-85

The following table accentuates the difference in the two series, the San Francisco group containing fewer specimens that vary from what may be assumed to be the normal for the region.

	San Francisco.	Sausalito.
	<i>Per cent.</i>	<i>Per cent.</i>
Normal in all characters.....	38	14
Abnormal in one character.....	30	44
Abnormal in two characters.....	22	20
Abnormal in three characters.....	8	14
Abnormal in four characters.....	2	6
Abnormal in five characters.....	.....	2

The color characters of the two sets differ to a marked degree. All the specimens captured or seen in Golden Gate Park have the pronounced spotted pattern. Of those from the Sausalito peninsula about two-thirds of the examples are similarly marked, though in darker tones. The remaining one-third have the striped pattern; in these the ground is a dark brown, the dorsal and lateral spots are absent, the median and lateral stripes are distinct, and are without any red on the underside.

GEOGRAPHIC VARIATION.

In the Memoir of Doctor Ruthven it was pointed out that the specimens of this species became smaller, the head shields reduced in number, and the scale rows less numerous as the range extended to the north. The various sets presented in the following tables confirm these findings. The one additional fact brought out is that these dwarfed members of the species are prone to be found in localities having lower temperatures, rather than merely a higher latitude.

MERCED COUNTY, CALIFORNIA.

Scale formulas 21-23-21-19-17
21-19-17

Museum. Cal. Ac. Sci.	Locality.	Sex.	G.	A.	U.	Scale rows.					Pn. Asy.	Pro.	Pto.	Supral.	Infra.
						21+V.	22-V.	21-VI.	19-IV.	17 caud.					
13635.....	Los Baños.....	♂-♀	152	•	71	26	25	55	54	80	83	129	125	.....	10
13636.....	do.....	♂-♀	158	•	77	29	35	53	39	81	82	116	122	.....	•
							43	45	45						
13637.....	do.....	♂-♀	154	.....	(7)	27	28	60	81	85	112	115	.....	.....	10
13638.....	do.....	♂-♀	156	.....	99	.....	.....	73	81	88	98	.....	.....	.....	11-10
13640.....	do.....	♂-♀	153	.....	72	.....	.....	.....	80	88	97	.....	.....	.....	11
36071.....	do.....	♂-♀	154	.....	(7)	47	40	49	48	83	104	105	.....	.....	11-9
Univ. Cal. #428.	Gadwall.....	♂-♀	154	.....	(7)	28	30	60	62	81	82	114	111	.....	11

The color of the specimens from Los Baños is of one pattern: The ground a uniform light-brownish olive; faint trace of small dorsal spots; these tend to encroach upon the median stripe; the median stripe indicated by a paler tint than the ground color; below no spots.

MONTEREY COUNTY, CALIFORNIA.

Scale formulas 19-21-19-17
19-17
19-17-15

Museum Cal. Ac. Sci.	Locality.	Sex.	G.	A.	U.	Scale rows.					15 cont.	Pra. Gulars.		Pro.	Pto.	Supral.	Infra.
						19+VI.	21-VI.	19-IV.	17-VII.			Pra.	Ary.				
13756	Carmel	♂	157	•	•	38	39	55	79	81	•	1	3	1	•	•	10
13760	do.	♂	152	•	•	38	42	54	55	79	•	1	3	1	•	•	10
13761	do.	♂	149	•	•	•	•	•	•	•	•	1	3	1	•	•	10
13764	Monterey	♂	147	•	•	•	•	•	•	•	•	1	3	1	•	•	10
13765	do.	♂	155	•	•	•	•	•	•	•	•	1	3	1	•	•	10
13767	Carmel	♂	143	•	•	•	•	•	•	•	•	1	3	1	•	•	10
13767	do.	♂	155	•	•	•	•	•	•	•	•	1	3	1	•	•	10
13768	do.	♂	155	•	•	•	•	•	•	•	•	1	3	1	•	•	10
13769	do.	♂	146	•	•	•	•	•	•	•	•	1	3	1	•	•	10

The color of this set is as follows: The ground varies from a very dark red-brown to a dark brown; the dorsal and lateral rows of spots absent or when visible ranging from a mere shade darker than the ground color to sharply defined marks; the median stripe uniform canary yellow or mixed yellow and salmon; the lateral stripe yellowish green or nearly solid salmon.

SAN MATEO COUNTY, CALIFORNIA.

Scale formulas 19-17
19-17-15
17-15

Museum U.S.N.M.	Locality.	Sex.	G.	A.	U.	Scale rows.			Pra. Gulars.	Pro.	Pto.	Supral.	Infra.
						19-IV.	17-VII.	15 cont.					
50807	Half Moon Bay	♂	157	•	•	83	83	•	1	1	3	•	9-10
53539	San Andreas	♂	151	•	•	81	81	•	2	1	3	•	10
53540	do.	♂	144	•	•	75	75	133	2	1	3	•	10
53539	do.	♂	141	•	•	•	78	79	2	2	•	•	8-9

One of the most interesting garter snakes on record is Cat. No. 53539, U.S.N.M. (Orig. No. K. 103), collected by H. C. Kellers, United States Navy. It is the only specimen known from south of Eureka with the minimum formula of 17-15. Associated with this low scale count is a reduction in the supralabial shields to 7, a condition also found as far as this species is concerned only in the north.

ALAMEDA COUNTY, CALIFORNIA.

Scale formulas 21-19-17
19-21-19-17
19-17

Museum No. U.S.N.M.	Locality.	Sex.	G.	A.	U.	Scale rows.				Gulars.		Pro.	Pto.	Supral.	Infra.
						19+VI.	21-VI.	19-IV.	17 cont.	Pra.	Asy.				
52194.....	Alameda.....	♂	162	•	(?)	28	28	28	28	1	1	1	1	1	1
52195.....	do.....	♂	161	•	86	28	29	28	28	1	1	1	1	1	1
52196.....	do.....	♂	162	•	84	28	31	28	28	1	1	1	1	1	1
Cal. Ac. Sci. 13228.	San Leandro.....	♂	162	•	(?)	28	27	28	28	2	2	1	2	8	9
Univ. Cal. 5417	Berkeley.....	♂	158	•	80	23	26	27	28	2	2	2	2	8	10
5418.....	do.....	♂	158	•	82	26	27	28	28	2	2	1	2	8	10
5419.....	do.....	♂	158	•	78	26	27	28	28	3	1	1	2	8	10

The prevailing arrangement of color in this set is as follows: Ground dark olive brown; dorsal and lateral spots usually present in the young and absent in the adult; median stripe pale yellow in the young, orange or vermillion in the adult; lateral stripe light olive gray, with or without salmon; below uniform greenish gray, or with salmon spots.

SONOMA COUNTY, CALIFORNIA.

Scale formulas 19-17
19-17-15

Museum Cal. Ac. Sci.	Locality.	Sex.	G.	A.	U.	Scale rows.			Gulars.		Pro.	Pto.	Supral.	Infra.
						19-IV.	17-VII.	15 cont.	Pra.	Asy.				
28021.....	Seaggs.....	♂	158	•	90	85	86	125	123	1	1	1	8	10
28025.....	Springs.....	♂	180	•	86	79	83	128	133	1	1	1	8	10
28029.....	do.....	♂	162	•	87II-IV	88	91	.....	.....	1	1	1	8	10
28019.....	do.....	♂	150	•	71	80	82	.....	.....	2	2	1	2	8
28024.....	do.....	♂	150	•	(?)	77	79	.....	.....	1	1	1	2	8

The color pattern of this set is as follows: The ground is a dark olive brown; the dorsal and lateral rows of spots are usually absent or but faintly defined; the median stripe bright yellow; the lateral stripe yellowish gray; below uniform olive gray.

MENDOCINO COUNTY, CALIFORNIA.

Scale formulas 19-21-19-17
19-17-15

Museum Cal. Ac. Sci.	Locality.	Sex.	G.	A.	U.	Scale rows.					Gular.		Pro.	Pto.	Supral.	Infra.
						19+VI.	21-VI.	19-IV.	17-VII.	15 cent.	Pra.	Asy.				
28902.....	Comptche	♂	152	e	75	.....	.....	81 84	-III	.....	1 3	1	1	3	3	10
28903.....	do	♂	154	e	88	.....	.....	83 88	126 128	.....	1 1	1	1	3	3	10
28904.....	do	♂	153	e	75	.....	.....	83 88	141 141	.....	1 1	1	1	3	3	9 II+IV
28905.....	do	♂	157	e	75	28 36	51 61	85 88	108 118	.....	1 1	1	1	3	3	10
28906.....	do	♂	148	e	75	.....	.....	85 88	130 137	.....	1 1	1	1	3	3	9 II+IV
28907.....	do	♂	149	e	75	13 26	63 68	85 88	.....	.....	2 2	2	1	3	3	10

The color design of this set is as follows: The ground varies from olive brown to olive gray; dorsal and lateral spots when present small and indistinct; the median stripe distinct and yellowish or merely indicated as a lighter tint than the ground color; lateral stripe usually poorly defined.

DEL NORTE COUNTY, CALIFORNIA.

Scale formulas 19-21-19-17
19-17

Museum Cal. Ac. Sci.	Locality.	Sex.	G.	A.	U.	Scale rows.				Gular.		Pro.	Pto.	Supral.	Infra.
						19+VI.	21-VI.	19-IV.	17 cent.	Pra.	Asy.				
29076	Regua.....	♂	156	e	79 (II-III)	29 31	58 64	78 83	.....	1 3	1	1	3	3	10
29081	do.....	♂	155	e	80	.....	.....	77 79	.....	.....	.....	1	1	3	9
29073	do.....	♂	157	e	(?)	28 28	60 60	86 86	.....	.....	.....	1	1	3	9 II+III
29080	do.....	♂	147	e	(?)	.....	.....	74 75	.....	.....	.....	1	1	3	VIII+IX
29082	do.....	♂	152	e	68	.....	.....	84 86	.....	.....	.....	1	1	3	9

The colors are dull; ground dark brown; spots absent or indicated by darker tones; median stripe dull orange, lateral yellowish grey. This set begins to show the marked reduction in size that occurs to the north; the largest, No. 29081, measures 640 mm.; tail, 161; head, from tip of snout to behind angle of jaw, 22.5; snout, 7.2; eye, 3.5.

CURRY COUNTY, OREGON.

Scale formulas 17-19-17-15
17-15

Museum Cal. Ac. Sci.	Locality.	Sex.	G.	A.	U.	Scale rows.				Grass.			Supral.	Infra.	
						17+IV.	19-IV.	17-VII.	15 cent.	Pra.	Asy.	Pro.			
															Pto.
29272	Harbor.....	♂	139	e	70	27 33	40 47	27 34	41 48	85	81	....	1 3 1 3	7	8 III+IV 9
29274	.....do.....	♂	146	e	77	....	....	....	77	83	....	....	1 3 1 3	7	9
29275	.....do.....	♂	148	e	77	....	....	....	76	79	....	....	1 3 1 3	7	9
29268	.....do.....	♂	153	e	77	....	....	....	74	75	....	....	1 3 1 3	7	9
29273	.....do.....	♂	140	e	....	....	....	....	80	80	....	....	1 3 1 3	7	9
29277	.....do.....	♂	140	e	....	....	....	....	77	77	....	....	1 3 1 3	7	9
29278	.....do.....	♂	141	e	....	....	....	....	84	83	....	....	1 3 1 3	7	9
29269	.....do.....	♂	142	e	66	....	....	....	78	75	....	....	1 3 1 3	7	9
29276	.....do.....	♂	142	e	....	....	....	....	85	87	....	....	1 3 1 3	7	9
29271	.....do.....	♂	145	e	59	45	56	97	101	....	....	....	1 3 1 3	7	9
29279	.....do.....	♂	146	e	64	....	....	....	79	81	....	....	1 3 1 3	7	9
29270	.....do.....	♂	147	e	70	39	39	74	76	....	....	....	1 3 1 3	7	9

The color pattern of this set is quite simple; ground light olive brown, or brown; spots usually absent, or indicated as darker shades of brown; stripes indistinct or sharply marked, median brick red, ateral faintly paler than ground color; below bluish grey, with or without red.

It will be noted that the predominant type of scale formula is the one with 17 rows anteriorly and 15 posteriorly, this occurring in 75 per cent of the specimens. Those in the 17-19-17-15 class are either asymmetrical or have very few scales in the added IV row. All are of small size, the average being about 400 mm. in length.

In looking over the tables which will follow of series from localities to the north, it will be observed that the specimens are larger and the increased scale formula of 17-19-17-15 again prevails as it does to the immediate south. Incidentally, southwestern Oregon is one of the coldest portions of the Pacific coast region, and the localities mentioned to the north are actually much warmer. It becomes evident that the reduced size and lower scale counts in *T. ordinoides* are correlated with colder climate rather than mere extension of the range to more northern latitudes.

TILLAMOOK COUNTY, OREGON

Scale formulas 17-19-17-15
17-15

Museum Cal. Ac. Sci.	Locality.	Sex.	G.	A.	U.	Scale rows.				Gulars		Pto.	Supral.	Intral.						
						17+IV.	19-IV.	17-VII.	15 cont.	Pra.	Asy.									
															Pro.					
29688	Tillamook	♂	145	•	60	27	31	57	57	85	••••	2	2	1	3	7	8 II	10 VIII III	9 VIII	
29693	.....do.....	♂	146	•	(?)	36	37	53	50	90	87	••••	1	2	1	3	7			8
29690	.....do.....	♂	149	•	71	26	27	52	50	93	94	••••	1	2	1	3	7			8
29692	.....do.....	♂	142	•	59	26	37	56	90	101	100	••••	1	2	1	3	7		9 III	8
29694	.....do.....	♂	146	•	56	26	26	65	63	120	120	••••	1	2	1	3	7			8
29697	.....do.....	♂	150	•	(?)	38	43	58	90	88	••••	1	2	1	3	7			8	
29695	.....do.....	♂	152	•	(?)	38	43	58	90	88	••••	1	2	1	3	7			8	

This set has the normal scheme for the northern limits; ground brown; spots absent or small; median stripe orange or yellowish green. The largest (No. 29694) measures 496 mm.

CHEHALIS COUNTY, WASHINGTON.

Scale formulas 17-19-17-15
17-15

Museum Cal. Ac. Sci.	Locality.	Sex.	G.	A.	V.	Scale rows.				Gulars		Pro.	Pto.	Supral.	Intral.			
						17+IV.	19-IV.	17-VII.	15 cont.	Pra.	Asy.							
29940	Malbourne.	♂	139	•	(?)	30	27	53	53	78	1	2	1	3	6 III+IV	9 VII 9 VII 9 VII		
29938do.....	♂	143	•	63	20	22	58	57	90	87	1	2			1	3
29930do.....	♂	145	•	67	20	36	51	54	98	96	1	2			1	3
29932do.....	♂	147	•	63	30	30	55	55	88	88	1	2			1	3
29937	.....do.....	♂	147	•	61	.....	.....	.....	99	97	....	1	2	1	3	7	7
24101	Montesano.	♂	150	•	(?)	.....	.....	.....	88	90	....	0	4	1	3	7	7
29931	Malbourne.	♂	141	•	(?)	23	24	63	60	85	92	....	2	1	3	7	7
29935	.....do.....	♂	141	•	(?)	27	26	66	63	90	90	....	1	2	1	3	7
29936	.....do.....	♂	143	•	(?)	26	26	66	55	98	88	....	1	2	1	3	7
29933	.....do.....	♂	144	•	60	41	31	41	31	91	83	....	1	2	1	3	7
29939	.....do.....	♀	144	•	63	20	13	75	77	125	122	....	1	2	1	3	7
24102	Montesano.	♀	145	•	59	25	23	70	76	121	122	....	1	2	1	3	7
29934	Malbourne.	♀	146	•	57	23	23	56	52	84	83	....	1	2	1	3	7
24103	Montesano.	♀	148	•	59	26	28	69	70	115	110	....	1	2	1	3	7

The color pattern of these northern specimens is generally dull, not pronounced; ground olive grey; dorsal and lateral spots small and faint; median stripe barely a shade paler than the ground color, in others sharply defined.

PACIFIC COUNTY, WASHINGTON.

Scale formulas 17-19-17-15
17-15

Museum No. Cal. Ac. Sci.	Locality.	Sex.	G.	A.	U.	Scale rows.				Gulars		Pto.	Supral.	Infral.
						17+IV.	19-IV.	17-VI.	18 cont.	Pra.	Axy.			
29925	Trap Creek	♂-ad. 6.	144	•	(7)	22	22	58	54	107	103	•	•	9 VII 8
29924	.....do	♂-ad. 6.	146	•	72	25	31	54	58	113	118	•	•	9 VII 8
29923	.....do	♂-ad. 6.	146	•	•	•	•	108	108	108	108	•	•	9 VII 8
29925	.....do	♂-ad. 6.	146	•	(5)	+V	-IV	54	54	108	108	•	•	9 VII 8
						25	25	58	58	•	•	•	•	

This set has markedly somber hues; the ground dark brown; dorsal and lateral spots indicated by darker shades; median stripe narrow, pale yellow; lateral stripe distinct; below dark grey. The measurements of the largest specimen, No. 29923, are as follows: Total length, 516 mm.; tail, 115; head, 17; snout, 4.8; eye, 2.6 mm.

SUMMARY OF SCALE FORMULAE IN THAMNOPHIS ORDINOIDES.

A tabulated summary of the occurrence of the different scale formulae in these various sets will show at a glance the prevailing types for each locality; to facilitate comparison they are given as percentages.

Scale formulas.	California.									Oregon.		Washing- ton.		
	Merced.	Monterey.	San Mateo.	Alameda.	San Francisco.	Sausalito.	Marin.	Sonoma.	Mendocino.	Del Norte.	Curry.	Tillamook.	Chualar.	Pacific.
21-23-21-19-17.	72	.....	.....	.....	12	6	33	.....	.....	.....	.....	.....	.....	.....
21-19-17.	28	.....	.....	14	12	6	33	.....	.....	.....	.....	.....	.....	.....
19-21-19-17.	50	.....	71	56	66	.....	.....	33	40	.....	.....	.....	.....
19-21-19-17-15.	8	.....	.....	.....	.....	.....	.....	.....	.....	.....
19-17.	12	50	14	16	10	63	.....	.....	60	.....	.....	.....	.....
19-17-15.	37	25	.....	4	12	66	37	66	.....	.....	.....	.....	.....
19-17-15-13.	2	.....	.....	.....	.....	.....	.....	.....	.....
17-19-17-15.	16	57	.....	82	21
17-15.	25	.....	.....	.....	.....	.....	.....	76	28	.....	18	79
15-17-15.	1	.....	.....	.....
Asymmetrical.	4	4	.....	.....	.....	8	14	.....	.....	.....

This table brings out several instructive facts. The decrease in the number of rows in specimens from more northern regions is not a perfectly regular one, each locality having a decidedly different average. In the same locality there is never a single type. Where two or more formulas exist they are never equally divided among the specimens, one type regularly predominating to a marked degree.

NOTE ON SCALE FORMULA IN *THAMNOPHIS PARIETALIS* (SAY) AND *THAMNOPHIS COCCINUS* (HALLOWELL).

Another species of garter snake found in the same region with *T. ordinoides* is *Thamnophis parietalis* (Say) 1823; this form is noteworthy in possessing but one type of squamation, there being 19 rows anteriorly and 17 posteriorly. As this formula is a fairly prevalent one in *T. ordinoides* it will prove of interest to compare a small set of each species from the same locality. Specimens have been chosen from Skaggs Springs, Sonoma County, California, owing to this place being approximately in the middle of the area occupied by *T. ordinoides*.

SKAGGS SPRINGS, SONOMA COUNTY, CALIFORNIA.

T. ORDINOIDES.

Museum Cal. Ac. Sci.	Sex.	G.	Scale rows.	
			19-IV.	17 cent.
27940.....	Male....	157	80 79	.....
28029.....	...do....	162	88 91	.....
28024.....	Female..	150	77 79	.....
28019.....	...do....	150	80 82	.....
27938.....	...do....	160	84 85	.....

T. PARIETALIS.

28026.....	Male....	157	100 90	.....
28023.....	Female..	151	89 88	.....
28028.....	...do....	154	80 82	.....
28027.....	...do....	157	84 85	.....
28022.....	...do....	157	90 87	.....

This table shows that there is a tendency in *T. parietalis* for the 19-row zone to be continued a little further down the body. This, however, is merely a slight difference in the averages of two small sets.

The only remaining species found along the Northwest Coast is *T. coccinus* (Hallowell) 1852, this also presents the one scale count of 19-17.

TRASK, TILLAMOOK COUNTY, OREGON.

T. COCCINUS.

Museum Cal. Ac. Sci.	Sex.	G.	Scale rows.	
			19-IV.	17 cent.
29740.....	Male....	167	87 91	.....
29738.....	...do....	162	88 89	.....
29741.....	...do....	160	83 84	.....
29737.....	Female..	159	90 89	.....
29734.....	...do....	154	92 94	.....

This table shows that the IV row does not extend quite so far down the body as in *parietalis*.

SUMMARY OF SCALAE FORMULAS IN GENUS THAMNOPHIS.

Doctor Ruthven recognizes 19 species of garter snakes in North America. Among these there are known 11 distinct combinations of scale row counts. The occurrence of the various combinations among the different species may be seen from the following table:

Species.	21-23-21-19-17.	21-19-17.	19-21-19-17.	19-21-19-17-15.	19-17.	19-17-15.	19-17-15-13.	17-19-17.	17-19-17-15.	17-15.	15-17-15.
<i>Megalops</i>	*	*	*		*						
<i>Marciana</i>		*	*		*						
<i>Rudix</i>			*		*			*			
<i>Butleri</i>					*			*			
<i>Proximus</i>					*			*			
<i>Saurita</i>					*						
<i>Sackeni</i>					*						
<i>Angustirostris</i>	*	*	*		*						
<i>Elegans</i>		*	*			*					
<i>Ordinoides</i>	*		*	*	*		*		*	*	*
<i>Hammondi</i>		*	*								
<i>Melanogaster</i>			*								
<i>Scalaris</i>			*								
<i>Phenax</i>			*		*				*		
<i>Eques</i>					*			*	*	*	
<i>Sumichrasti</i>						*		*		*	
<i>Parietalis</i>					*						
<i>Coccinus</i>					*						
<i>Sirtalis</i>					*						

Inspection of this table shows that the formula of 19-17 is the most frequent, as it occurs in 12 species; also that there are eight species with only one scale row count, which in these cases is regularly one of the following three: 21-19-17, 19-21-19-17, or 19-17; and, finally, that in *Thamnophis ordinoides*, there are to be found twice as many combinations as are to be seen in any of the other species.

If *ordinoides* is a valid species it offers an example at variance with the prevailing condition in which it is the species with the widest ranges that vary the most, for *ordinoides* has one of the smallest areas of distribution in the genus. If the converse is true, which is most probable, and it ultimately proves to be inseparable from *elegans*, it will then conform to the rule in having a wide distribution and a large variability.

The handling of large series of garter snakes will inevitably result in bringing about a readjustment and broadening of one's concept of what may be implied by Wallace's phrase: "The variability of a species in the state of nature."

TROPHODISCUS, A NEW SEA STAR FROM KAMCHATKA.

By WALTER K. FISHER,
Of Stanford University, California.

The new genus and species described herewith belongs to the family Astropectinidae, and stands near to *Leptychaster*, especially to *Leptychaster propinquus* and *L. anomalus*. In *Leptychaster*, or rather in those species of the genus found in the northern hemisphere, the gonads have a very characteristic distribution which so far as now known is not found elsewhere among starfishes. In the great majority of sea stars the gonads are confined to the interradial region and usually form a single tuft or cluster of tubules on either side of the interbrachial septum. In *Leptychaster* this is true of the ovaries only, while the testes form a series of clusters hanging from the genital stolon, and extending about a third the length of the ray measured along the side. In the new genus, as well as in *Dipsacaster*, *Tethyaster*, and several other genera of the Astropectinidae both the ovaries and testes are so distributed, without any apparent difference, other than the cellular structure. The gonads are, therefore, serially arranged.

Trophodiscus may be distinguished from the shorter-rayed species of *Dipsacaster* by the uncovered, relatively smaller madreporic body, by the interruption of the papular area along the midradial line (where, in *Dipsacaster* the papulae are normally largest), and by the wholly unarmed inferomarginals (except *D. anoplus* Fisher). No species of *Dipsacaster*, so far as known, broods its young.

TROPHODISCUS, new genus.

Characters.—Near to *Leptychaster* Smith, but differing in having both ovaries and testes serially arranged along each side of the proximal half of the ray. Form stellato-pentagonal; with conspicuous marginals, large compact paxillae, carinated actinal intermediate plates, and a pectinate furrow armature; no enlarged marginal spines; an incomplete interradial series of actinal intermediate plates; madreporic body uncovered; papulae absent from center of disk and a very narrow radial area. Young carried on back of the female, among the paxillae.

Type.—*Trophodiscus almus*, new species.

TROPHODISCUS ALMUS, new species.

Description.—Rays 5. $R = 43$ mm., $r = 26$ mm., $R = 1.65 r$; cotype: $R = 39$ mm., $r = 25$ mm., $R = 1.56 r$. General form stellato-pentagonal with short, broad rays, arcuate interbrachia, and slightly to decidedly swollen abactinal area, broadly margined by the short, wide infero-marginal plates; rays evenly tapered beyond the base to a bluntly pointed extremity.

When the abactinal integument is not stretched the paxillae are very compactly placed. They are largest at about the middle of R (at base of ray proper), whence they decrease in size only slightly laterally, but gradually toward the end of the ray, where the crown is only one-half to one-third the width of the largest paxillae. Inside a circular area bounded by the madreporic body the paxillae rapidly become smaller toward the center of the disk. The large paxillae have a convex crown of 20 to 30 subtruncate, or round-tipped slightly clavate spinelets, about 4 to 5 times as long as their breadth at tip and about 2 to 2.5 times the length of the stout, slightly flaring pedicel of the paxilla. The 10 to 15 spinelets on the convexity of the tabulum are a trifle stouter than the peripheral ones.

The abactinal plates, or bases of the paxillae, viewed from the coelomic side show two principal forms. Those of the central area of disk and a median band along the ray are subcircular or very broadly elliptical, the margin being slightly crenulated or incipiently lobed in most cases. The plates touch each other or even slightly overlap. On the disk they are more crowded than on the outer part of the ray. On the lateral areas of rays and disk the plates are more widely spaced and have 4, 5, or 6 distinct but irregular lobes. Along a narrow zone next the marginal plates the abactinal plates quickly become smaller, with short, overlapping lobes.

The papulae are absent from the center of the disk and a very narrow midradial band, upon which a papula will sometimes encroach. They are best developed wherever the abactinal plates have well-marked lobes.

Supermarginal plates 19, forming a broad, slightly raised, beveled margin or frame to the abactinal surface. The plates are short and relatively broad, and decrease regularly in width toward the end of ray. They are covered with fairly large polygonal granules, which form an irregular tessellation and increase slightly in size toward the outer, rounded end or edge of the plate. The granules are rather squamiform in appearance, except the peripheral which are slenderer and spiniform.

Inferomarginal plates 19, slightly broader than the superomarginals and extending laterally beyond them a variable but short distance (not more than a fourth the width of the superomarginals; in the type less), so as to define the ambitus in the interbrachium at least. In-

feromarginal granules squamiform, increasing in size toward the outer margin of the plate where they are larger than the corresponding superomarginal granules. The marginal plates have deep fasciolar grooves between their specialized raised ridges. The grooves in the interbrachium are about three-fourths the width or thickness of the intervening ridges, and on the rays about one-half. Unless the granules are removed the grooves are entirely hidden.

Actinal intermediate plates arranged in very regular series leading from the adambulacral plates to margin, and also in about six series parallel to the adambulacrals. There is an odd interradiial series, starting outside a pair of plates opposite the outer end of mouth plates and nearly reaching the margin. The plates have elliptical, transversely oriented pedicels or tabula (separated by fasciolar channels), bearing a paxilliform group of 15 to 18 peripheral and about 12 to 18 stouter central spinelets. The spinelets are short, clavate, and are more or less bent or dressed toward the margin, the ends of the central spinelets being obliquely truncated and somewhat flaring.

Adambulacral plates with a somewhat tabulate surface, there being a well-defined groove between this and the adjacent actinal intermediate plates, and a slightly deeper groove separates consecutive plates. The armature consists of a peripheral series of about 13 spines of which 6, or 5, stand on the furrow margin and form a regular comb. These spines are roughly four-sided and bluntly pointed, or round-tipped (the end being beveled), and the adoral, as well as sometimes the aboral, are shorter than the central four. The other peripheral spinelets are a little longer than the adjacent actinal intermediate spinelets. Four to six subambulacral spines form usually two series, or a group. In the type there are often two well-defined longitudinal, subambulacral series of four or five spines each, as well as several on the outer edge of the plate.

Mouth plates prominent and rather narrow at the outer end, and flaring to form a broader lanceolate inner half. Marginal spines about 12, largest at the inner end. There is a series of short spines along the median suture margin, a similar series along the center of each plate, and a series of slenderer spinelets along the margin adjacent to the first adambulacral. First adambulacral moderately compressed.

Madreporic body subcircular, convex, not hidden by paxillae. It is situated nearly midway between the center and inner margin of the superomarginal plates. Striae irregularly radiating, branched. The margin is overhung more or less by paxillae, but these do not spring from the surface as in *Dipsacaster*. Anal aperture small but distinct. Gonads, both ovaries and testes, in small branched tufts hanging from a genital rachis which lies nearly midway between median radial line and the margin. The tufts extend about half the length of ray meas-

ured along side. Hepatic coeca short, with few thick, saccular, lateral pockets. Intestinal coecum small, saccular. Interbranchial septum membranous. Superambulacral plates present. Tube-feet pointed; ampullae large, double.

The large saccular stomach consists of only a single chamber, there being no trace of a dorsal division. The short hepatic coeca are arranged about equidistantly on the circumference. In the stomach is a bivalve—a *Yoldia* or related form—22 by 12 mm. It is remarkable that such a large body could be swallowed.

Young.—Among the paxillae of the abactinal surface are 28 young starfishes, and in addition the forms where three others have been. These vary in size from 3 to 8 mm. in diameter, and their distribution coincides exactly with that of the gonads. Another curious circumstance: The largest young are found nearest the interradiial line, while the others with a few exceptions are graduated in size distad, just as the tufts of the gonads are. The smallest young are nearly covered by the overarching paxillae, but as they increase in size the paxillae are pushed aside and the intervening abactinal membrane is stretched to extreme thinness. Viewed from the coelomic side, the young, which form a sort of excrescence impinging upon the coelomic space, can be seen through the semitransparent integument. The young have no organic connection with the parent. Since they lie immediately over the apertures of the gonads, it is possible that they grow by feeding upon ova which are extruded for that purpose. Or, there is a possibility that they may use coelomic fluid received through a papular pore, produced by the simple process of digesting the papula itself. The abactinal membrane is thin enough so that fluid might be actually drawn through it if the stomach could perform a sucking process. Lastly, the tips of the rays are usually turned upward a bit so that food currents might readily conduct microscopic organisms to the mouth along the ambulacral groove. An examination of the stomach of one of the larger individuals did not reveal the exact nature of the food. The stomach was full of a material, apparently solidified by alcohol, in which I was able to distinguish what appeared to be fragments of cells, but no silicious or calcareous remains.

The stomach of a small individual was partly everted. The cotype, a male, has no young on the abactinal surface.

Sladen, in the *Asteroides* of the *Challenger* expedition,¹ has figured a specimen of *Leptychaster kerguelensis* Smith, with numerous young on the abactinal surface. In this species the young leave the arcade-like spaces among the paxillae, and remain on the surface of the paxillae with their actinal side outward.

Type.—Cat. No. 37029, U.S.N.M.

¹ *Challenger Asteroides*, 1880, pl. 81, fig. 1.

Type-locality.—*Albatross* station 3644, southeast coast of Kamchatka, lat. $51^{\circ} 16' N.$; long. $157^{\circ} 48' W.$, 96 fathoms, black sand, bottom temperature 33.1° Fahrenheit; 2 specimens.

Location of the gonads in Leptychaster.—In four species of the genus *Leptychaster*, which I have been able to examine, the testes differ in distribution from the ovaries. In *L. arcticus*, *L. pacificus*, *L. propinquus*, and *L. anomalus* (the last three being North Pacific species) the ovaries are in a single tuft close to the interradiial septum—a pair, thus, in each interbrachium. In some specimens the branches may extend far along the ray, but they are attached in only one place, as stated above. In the male the gonads form a series of independent tufts of tubules, parallel with the margin, and distributed for a third to nearly a half the length of ray, according to the size of the specimen. The distribution of the testes in the above species of *Leptychaster* is therefore similar to the distribution of both ovaries and testes in *Trophodiscus*, *Dipsacaster*, *Ctenopleura*, *Tethyaster*, *Thrissacanthias*, and other genera. This condition of the gonads is apparently characteristic of the genus *Leptychaster*, although of course, it will doubtless be found to be true of other genera. The reason I did not discover this when working up my North Pacific Asteroidea, Part I, was the fact that I dissected then only a single example of each species, which happened in all cases to be a female. Recently, at the United States National Museum, I found “serial gonads” in a specimen of *L. arcticus*, from station 21, Cashes Ledge. A specimen from station 4779 (North Pacific) has serial gonads and is a *male*, while a *female* from station 5047 has strictly interradiial, nonserial, gonads.

This arrangement of the gonads holds true in all specimens examined, namely:

Leptychaster propinquus, 2 males and 3 females; station 4788.

L. anomalus, 1 male, station 4233; 1 female, station 4280.

L. pacificus, 1 male, station 3223; 2 females, station 2862.

EXPLANATION OF PLATES.

All figures are of *Trophodiscus almus*.

PLATE 28.

Abactinal surface of the holotype, showing the young among the paxillae.

PLATE 29.

Actinal surface of the paratype.

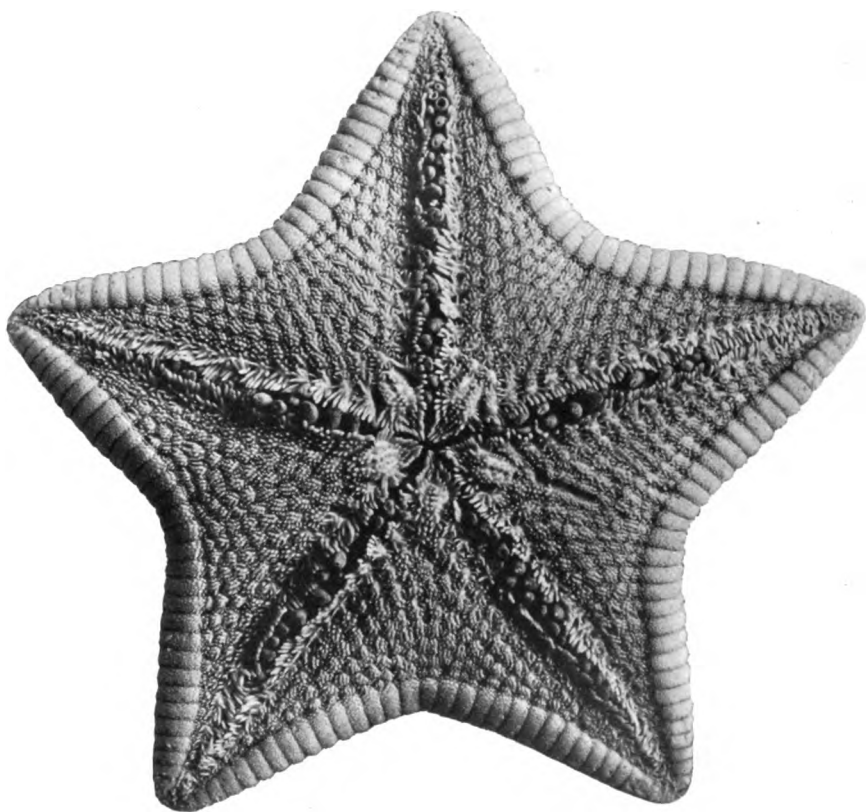
PLATE 30.

Base of ray and portion of disk, enlarged to show the young. The arrows point to very small young.



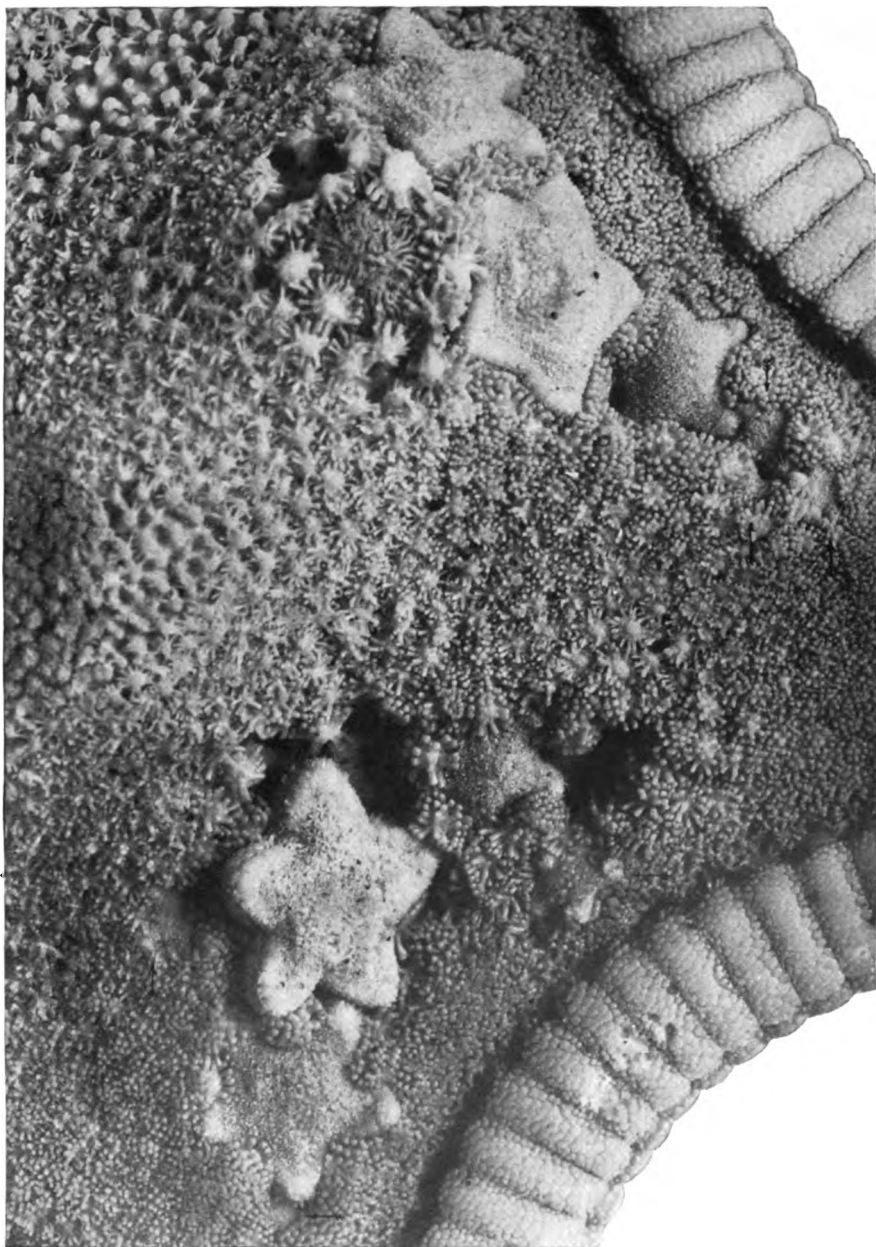
ABACTINAL SURFACE OF *TROPHODISCUS ALMUS*.

FOR EXPLANATION OF PLATE SEE PAGE 371.



ACTINAL SURFACE OF *TROPHODISCUS ALMUS*.

FOR EXPLANATION OF PLATE SEE PAGE 371.



RAY AND DISK OF *TROPHODISCUS ALMUS*.

FOR EXPLANATION OF PLATE SEE PAGE 371.

NEW TERTIARY INSECTS.

By T. D. A. COCKERELL,

Of the University of Colorado, Boulder.

The insects now described come from three different localities and horizons. One species was obtained by the United States Geological Survey in the oil shales (Eocene) of western Colorado. Others are from Florissant, Colorado, where they were obtained in the well-known Miocene shales. These include, in addition to a number of new species, new genera of Diptera and Hymenoptera. All the above are in the United States National Museum, but I have also included some descriptions of species from the Oligocene of Gurnet Bay, Isle of Wight, England, transmitted for examination by the British Museum, through the kindness of Dr. F. A. Bather. These came originally from the collection of the Rev. P. B. Brodie, as did those in the United States National Museum which I recently described in these proceedings.¹

DIPTERA.

RIPHIDIA BRODIEI, new species (*Tipulidae*).

Plate 31, fig. 2.

Wing about 5 mm. long and 1.5 wide, pale brownish, with very faint clouds at ends of first marginal and first basal cells; costa with minute bristles, but no evident bristles on the veins; venation almost exactly as in *R. maculata* Meigen. The following wing measurements are in microns: first basal cell on first marginal (not allowing for curve) 770; first basal on submarginal (not allowing for curve) 432; first basal on first posterior, 130; first basal on discal, 336; upper side of discal cell, 640; discal on second posterior, 130; discal on third posterior, 320.

Oligocene: Gurnet Bay (Brodie). British Museum, I. 8603.

MONGOMA CRUCIFERELLA, new species (*Tipulidae*).

Plate 31, fig. 3.

Wing about 5 mm. long, hyaline, without spots, veins brown; venation agreeing in general character with living *Mongoma*, the anterior cross-vein apparently absent (fused with R_{4+5}); veins at apex of first

¹ Proc. U. S. Nat. Mus., vol. 51, 1916, pp. 86-106.

marginal cell forming a cross or X, R_2 proceeding from the apical point of the cell; veins apically limiting basal cells oblique, in a straight line with one another, exactly as in *M. niveitarsis* Alexander. The following measurements are in microns: length of first marginal cell, 1950; first basal on submarginal, 400; apical side of first basal, 224; apical side of second basal, 320; first marginal on first submarginal, 800.

Oligocene: Gurnet Bay (Brodie). British Museum, I. 8635. The X at end of first marginal cell is distinctive. The position of R_2 shifts in various members of the genus. In *M. pallida* Williston and *M. fragillima* Westwood it separates considerably beyond the end of first marginal cell, but in *M. niveitarsis* it is before (basad of) the tip of that cell, or rather originates from the upper corner of the truncate tip. The genus *Mongoma* is today tropicopolitan, and on account of the diversity of venation has been divided by authors, but Alexander shows that the groups grade into one another.

TIPULA GARDNERI, new species (Tipulidae).

Plate 31, fig. 1.

Wing about 18 mm. long and 4 wide, the apex low down, giving the wing a subfalcate appearance; no distinct markings but a dark gray stigmatic cloud, the end of which is 5 mm. from apex of wing; second vein (R_{2+3}) not evidently turned upward at end; third vein going to wing tip; costal vein bounding marginal and submarginal cells very strong and dark; discal cell rather long and narrow, as in some of the American Miocene (Florissant) species; fifth posterior not quite touching discal.

Oligocene: Gurnet Bay (Brodie). British Museum, I. 8663. This is readily known from the species of Baltic amber by its size. It is named after J. S. Gardner, who is known for his work on the Tertiary plants of England.

BIBIO WICKHAMII Cockerell (Bibiidae).

A new specimen from Florissant (U.S.N.M.) has the following characters: Length about 11.25 mm.; wing, nearly 7; head, thorax, and legs, black; abdomen, reddish brown, with broad hyaline bands, which are about half as wide as the intervals between them; wings hyaline, the costal field broadly suffusedly brownish, a large dusky stigmatic spot. Wing measurements in microns: Third vein before anterior cross-vein, 640; third vein beyond cross-vein, 3,520; cross-vein, 80; width of first posterior cell at level of end of third vein, 640; width of second at same level, 608; third posterior cell on wing margin, 1,280.

BIBIO GURNETENSIS, new species.

Plate 31, fig. 4.

Wing about 5 mm. long, clear hyaline, stigmatic region pale brownish, venation normal for the genus. The following measurements are in microns: Upper apical side of first basal cell, 145; lower apical side (on first posterior) of first basal, 640; second basal on first posterior cell, 960; second basal on fourth posterior, 1,040.

Oligocene: Gurnet Bay (Brodie). British Museum, I. 8641. The apical sides of the first basal cell (the upper short, the lower, or cross-vein, long) are like those of the Florissant fossil *B. atavus* Cockerell. Meunier lists no species of *Bibio* from Baltic amber.

BIBIO OLIGOCENUS, new species.

Plate 31, fig. 5.

Wing about 8 mm. long, fuliginous; the whole costal region very dark. Venation normal for the genus. Stem of vein, 2-3 before discal cross-vein 896 microns long, and discal cross-vein only 256 microns. Lower end of discal cross-vein 1,440 microns apicad of level of basal corner of fourth posterior cell.

Oligocene: Gurnet Bay (Brodie). British Museum, I. 8650. Readily distinguished by the dark wings and the venation as described.

PLECIA WINCHESTERI, new species (Bibionidae).

Wing about 7.3 mm. long and 3 broad, dilute fuliginous; third vein rather strongly arched; anterior cross-vein shorter than distance from it to fork of fourth vein. A broad-winged species of normal type. The following measurements are in microns: Third vein from origin (separation from first) to anterior cross-vein, 1,520; third vein from anterior cross-vein to fork, 1,330; length of upper branch of third vein (second vein), 960; third vein from fork to end (lower branch) 2,240; length of anterior cross-vein, 240; anterior cross-vein to fork of fourth, 400; fourth posterior cell on wing-margin, 1,490. The second posterior cell on upper side is slightly over 3 mm. long.

Oil shales (Eocene), banks of Hay Gulch (S. E. quarter of section 36, township 1 N., Range 96 W), Colorado, September 9, 1914 (D. E. Winchester), United States Geological Survey. This is very possibly the female of *P. woodruffi* Cockerell, but if so, this can not be proved, and as the locality is different, I give it a distinctive name. The wing is colored exactly like that of *P. fulvicollis* Fabricius, from Los Banos, Philippine Islands (Baker).

Type.—Cat. No. 62535, U.S.N.M.

PLECIA EXPLANATA, new species.

Male.—Length, about 7.3 mm. as preserved, but end of abdomen gone; black or dark brown, abdomen not banded; wings quite long and narrow, 8 mm. long and 2.9 broad, dusky; anterior femora very robust. Anterior cross-vein shorter than distance from it to fork of fourth; anal cell narrowly open. The following measurements are in microns: Depth of marginal cell at level of anterior cross-vein, 368; third vein from origin to fork, 2,400; third vein from fork to end (lower branch), 2,320; length of upper branch of third (second vein), 800; depth of submarginal cell at level of end of second vein, about 288; third vein from origin to anterior cross-vein, 1,330; length of anterior cross-vein, 240; anterior cross-vein to fork of fourth, 320; base of third posterior cell to basal corner of second, 1,200; fourth posterior cell on wing-margin, about 1,440.

Florissant, in the Miocene shales. A relatively narrow-winged species, readily known from the other Florissant forms by the measurements.

Type.—Cat. No. 62536, U.S.N.M.

ACREOTRICHITES, new genus (Bombyliidae).

Small flies allied to *Acreotrichus* Macquart; body not hairy; thorax robust, elevated in profile; abdomen rather slender; antennae with very long black hair, arranged nearly as in *Acreotrichus*, the first two joints densely hairy, the third long-pyriform, with a tuft of long hair. Wings with four posterior cells, all wide open; second submarginal very long and narrow, flaring apically; second vein not turned up at end; discal cell small, the anterior cross-vein much before its middle; praefurca short; anal cell very broad, closed a short distance before wing-margin.

Type of the genus.—*Acreotrichites scopulicornis*, new species.

ACREOTRICHITES SCOPULICORNIS, new species.

Plate 31, fig. 6.

Length, 4.5 mm.; wing, 3 mm.; black, with smoky wings. The following measurements are in microns: Praefurca, about 350; length of second submarginal cell on lower side, 1,010; basal corner of second submarginal apical of vertical level of end of discal cell, 112; discal cell on first posterior, 656; discal on first basal, about 320; discal on fourth posterior, 480; width of anal cell at level of base of fourth posterior, 320; posterior cells on wing-margin, first and second, each 240, third 480, fourth 832. Vein separating discal cell from third posterior having a double curve (as in *Systropus foenoides*).

Florissant, in the Miocene shales. It was preserved on the same piece of shale as *Urotales caudatus*, about 25 mm. away from it.

Type.—Cat. No. 62537, U.S.N.M.

The genus *Acreotrichus* was based on the Australian *A. gibbicornis* Macquart. The fossil is evidently allied, but generically distinct. *Acreotrichus atratus* Coquillett, from the State of Chihuahua, Mexico, appears to represent a third genus; I examined the type some years ago in the United States National Museum. All these flies are very easily known from *Phthiria* by the remarkable antennae. The three genera may be separated thus:

Anterior cross vein much before middle of discal cell; second submarginal cell long and narrow, not truncate at base..... *Acreotrichites*, new genus.

Anterior cross-vein beyond middle of discal cell..... 1

1. Anterior cross-vein not far beyond middle of discal cell; second submarginal cell not truncate at base; third antennal joint about three times as long as the first two together..... [*Neacreotrichus*, new genus (type, *Neacreotrichus atratus* = *Acreotrichus atratus* Coquillett).

Anterior cross-vein far beyond middle of discal cell; second submarginal cell truncate at base, with an appendicular nervure directed basad from its upper basal corner; third antennal joint not nearly three times as long as first two together.

Acreotrichus Macquart.

MESOMYITES, new genus (Empididae).

Minute flies with narrow wings (shaped much as in *Toreus*); second vein short, directed obliquely upward, reaching costa far from apex of wing; third vein long, simple; praefurca very long; discal cell long, complete, emitting three veins from its apical part; anterior cross-vein near base of discal cell; four posterior cells; lower apical corner of second basal level with apex of first basal cell; anal cell apparently wide open on margin. Third vein obliquely deflected between separation of second and anterior cross-vein.

Type of the genus.—*Mesomyites concinnus*, new species.

MESOMYITES CONCINNUS, new species.

Plate 31, fig. 7.

Wing about 3 mm. long, hyaline, veins brown; costa minutely bristly. The following measurements are in microns: Width of wing, 850; basal end of praefurca to apex of wing, 2,144; end of second vein to level of tip of wing, 1,170; upper side of first posterior cell, 1,360; marginal cell on submarginal, 400; first posterior on discal, 720; first posterior on second posterior, 690; first posterior on wing margin, 128; second posterior on wing margin, 240; second posterior on third, 560; width (depth) of discal cell, 112; discal on second posterior, 80; discal on third posterior, 112; discal on fourth posterior, 640; apex (upper apical corner) of second basal apicad of level of apex of first basal, 128. The last 640 microns of anal vein are visible, without any sign of a closed anal cell. At the upper basal

corner of fourth posterior cell are three little cells, representing an abnormality only.

Oligocene: Gurnet Bay (Brodie). British Museum, I. 8666. This minute fossil fails to show the base of the wing, but most of the venation is very well preserved. I can only interpret it as a relative of *Mythicomyia*, which has the same type of second vein, only more extreme. In *Mythicomyia* the third vein may be a little deflected at the anterior cross-vein, or it may be straight. The anal cell is usually closed, but Cresson shows that it may be narrowly open. The shape of the wing in *Mythicomyia* is very different from that in the fossil. Cresson and others place *Mythicomyia* in the Empididae, and the fossil must be referred to the same family.

RHAMPHOMYIA HYPOLITHA, new species (Empididae).

Plate 31, fig. 8.

Male.—Length, 6 mm.; wings, 4 mm.; head, thorax, and legs black; abdomen slender, dark brown; wings dusky, but not fuliginous; proboscis directed downward, somewhat longer than head; antennae about 608 μ long, the end formed as in *R. sepulta*. Praefurca very short, strongly curved; anterior cross-vein before middle of discal cell; anal cell as usual in the genus. The following measurements are in microns: Praefurca, not allowing for curve, about 176; submarginal cell at apex, not allowing for curve of margin, 880; first posterior cell on wing margin, 400; second posterior on margin, 560; basal corner of discal cell basad of vertical level of end of praefurca, 96; first basal cell on submarginal, 240; first basal on discal, 320; first posterior on discal, 560; total length of discal, 880.

Florissant, in the Miocene shales. Easily known from *R. sepulta* Cockerell, the other Florissant species, by the wing measurements.

Type.—Cat. No. 62538, U.S.N.M.

URORTALIS, new genus (Ortalididae).

A genus of the subfamily Richardiinae, with extremely long, tapering ovipositor; wings without any conspicuous markings. Costa minutely bristly; auxiliary vein approaching costa very obliquely; first vein without bristles; second vein straight at end (not curved upward as in *Richardia*); first posterior cell not at all contracted apically; superior apical corner of discal cell forming an obtuse angle. Hind femora stout; whether toothed or not can not be determined. The venation, except for the shape of the first posterior cell, is nearly as in *Epiplatea*; as in that genus the basal costal region is large, not narrowed as in *Stenomacra*. The region of the anal cell is extremely obscure, but it seems to be short and truncate or subtruncate. This is not a very satisfactory genus, the characters of the

head, so important in this group, being wholly obscure. At the same time, it is a remarkable insect, and it seems impossible to refer it with any assurance to a living genus.

Type of the genus.—*Urortalis caudatus*, new species.

URORTALIS CAUDATUS, new species.

Plate 31, figs. 9, 10.

Female.—Body apparently black; thorax about 4 mm. long; abdomen, with the long slender ovipositor, about 7.5 mm. Wings about 4.4 mm. long, hyaline, with broad but extremely faint clouding along the veins. The following measurements are in microns: End of auxiliary vein to base of wing, about 1,360; end of auxiliary vein to end of first, about 720; end of first to vertical level of tip of wing, 2,480; first basal cell on submarginal, 1,470; first basal on first posterior, 176; width of first posterior near middle, 448, and at apex, 528; discal on first posterior, 960; discal on second posterior, 576.

Florissant, in the Miocene shales.

Type.—Cat. No. 62539, U.S.N.M.

MELIERIA ATAVINA, new species (Ortalididae).

Robust, dark brown, about 8 mm. long, wings a little over 6 mm. The thoracic bristles can not be made out, but the characteristic long bristles, curved backward, on the top of the head, are plainly visible. Wing pattern very distinct, essentially as in *M. obscuricornis* Loew, except that the apical patch is formed as in *M. ochricornis* Loew, and there are two bands on the basal part of the wing, one broad, the other (more basal) small. The broader of these bands is well represented in *M. similis*, but does not extend right across the wing as in the fossil. First posterior cell contracted apically, though widely open; anterior crossvein far toward end of discal cell (as in *Richardia*); anal cell with the end transverse and bulging (much as in *Coelometopia*), and a considerable distance basad of end of second basal. The following measurements are in microns: End of second vein to end of third, in a straight line, 1,120; length of anterior cross-vein, 480; length of upper side of discal cell, 1,872; base of discal cell to end of anal, 400; discal on first posterior, 480; apical side of discal cell, 800. End of praefurca very slightly basad of level of apex of anal cell.

Florissant, in the Miocene shales. Although this is a prettily marked fossil, the structural characters are hard to discern. The shortness of the anal cell as compared with the second basal, as well as its form, might indicate a genus distinct from *Meliera*, but the general resemblance to *Meliera* is so striking that the generic reference seems almost obligatory.

Type.—Cat. No. 62540, U.S.N.M.

PROTOSCINIS, new genus (Chloropidae).

Minute flies closely resembling *Botanobia* (*Oscinis*), but second vein leaving first basal cell very near its base, and anterior cross-vein much before middle of combined discal and second basal cell. Costal vein going as far as tip of fourth; costa with small stiff black bristles, about six in 80 microns; second vein straight, faintly curved upward at end; third and fourth veins not converging distally; lower side of discobasal cell not at all bulging outward (downward).

Type of the genus.—*Protoscinis perparvus*, new species.

PROTOSCINIS PERPARVUS, new species.

Plate 31, fig. 11.

Thorax robust, black, 640 microns wide; wing 1728 microns long, hyaline. The following measurements are in microns: Base of wing to end of first vein, 512; width of submarginal cell at level of end of second vein, 192; third vein from level of end of second to tip of wing, 352; first posterior cell on wing margin, 192; width of first posterior cell at level of end of discobasal, 160; first posterior on discobasal, 416; total length of discobasal, 560; second posterior on discobasal, 160.

Oligocene: Gurnet Bay (Brodie), British Museum, I. 8632.

The venation is not very different from that of *Ops glaberrima*, as figured by Lamb. Possibly the fossil could be referred to *Ops*, but that name is preoccupied.

ANTHOMYIA (sens. lat.) PERSEPULTA, new species.

Length 5.7 mm., wing, 4.3 mm.; robust, black or dark brown, wings dusky; abdomen thinly beset with long bristles; hind tibia with a few long bristles on posterior margin; eyes (in lateral view) semicircular; mouth parts and palpi as in *Anthomyia*. Wings broad; venation normal; auxiliary vein strong, only close to first vein toward base; upper apical angle of discal cell a right angle; upper basal angle of second posterior cell an obtuse angle; first posterior cell scarcely at all contracted apically. The head is small, in lateral profile (including position and shape of eye) nearly as in male *Phyllogaster cordyluroides*, though not so high. The following measurements are in microns: Base of wing to end of auxiliary vein, about 1040; submarginal cell on wing margin (not allowing for curve), 752; base of wing to anterior cross-vein, about 1552; anterior cross-vein to upper apical corner of first posterior cell, 2560; width of first posterior about middle, 544; first posterior on discal, 830; second posterior on discal (the apical side of which is straight), 560; lower apical corner of discal to wing-margin.

Florissant, in the miocene shales. Closely resembles *A. atavella* Cockerell, but easily distinguished by the dusky wings, strong auxiliary vein ending much nearer base of wing, and thorax longer and less convex in profile. It certainly represents a distinct genus from *A. atavella*, but it is impossible to place these fossil Anthomyidae in the genera of modern authors, which are separated principally on characters we can not see.

Type.—Cat. No. 62541, U.S.N.M.

THYSANOPTERA.

AEOLOTHRIPS BRODIEI, new species (*Aeolothripidae*).

Plate 31, fig. 12.

Length about 1.3 mm.; head and thorax poorly preserved; abdomen large, dark brown, with hyaline sutural bands (caudal bristles not visible, being embedded in rock); wings short, not nearly reaching end of abdomen; venation as usual in the genus, the two longitudinal veins very distinct, the first, at least, with minute bristles; cross-veins placed practically as in *Orothrips kelloggi* Moulton, the one connecting the longitudinal veins oblique as in that species; the cross-veins from first longitudinal to costa are subobsolete, but two seem to be indicated, the two from second vein to lower margin are more distinct; the bristles of the costal region are short, and those of apex and inner margin are less than twice as long. Wings pale brownish, not banded, veins brown. The following measurements are in microns: Length of abdomen, 975; width of abdomen, 400; width of wing, 175; length of costal bristles, 32; length of bristles at apex of wing, 50; cross-vein between longitudinal veins to second cross-vein from second longitudinal to margin, 160; second cross-vein from second longitudinal to margin to end of second longitudinal, 175.

Oligocene: Gurnet Bay (Brodie; British Museum, I. 8547). This may not belong to *Aeolothrips* in the most restricted sense, but it appears to show no distinctive characters excluding it from the genus. In the absence of banding on the wings it resembles *Ankothrips* Crawford, but that has narrower, much more bristly wings.

NEUROPTERA.

SISYRA(?) DISRUPTA, new species (*Homocididae*).

Plate 31, fig. 13.

Represented by part of the apical region of a wing which must have been about 5 mm. long. It appears to be referable to the Sisyridae (*Sisyridae* Handlirsch), and has exactly the texture and general appearance of the wing of modern *Sisyra* (*S. vicaria* Walker, collected

by N. Banks at Great Falls, Maryland, compared), with the very prominent spurious veins between the real ones. The venation, however, differs in detail. R_2 has a long fork, but R_2 and R_3 , more as in *Micromus*, are forked so briefly as to appear simple, the apical margin of the wing not being preserved. The very complicated R_4 (as I understand Needham's nomenclature) has the first branch divided, each division again forked, while the other two branches are each forked. The first fork of the media only is visible. The following measurements are in microns: Fork of R_2 across wing to fork of first branch of R_4 , 800; fork of first branch of R_4 to margin of wing, 1600, the upper and lower cells in the secondary forks of its branchlets, respectively, 865 and 320 long; length of cells in forks of second and third branches of R_4 , each 480; length of cell in first fork of media, 560. These cells are measured from fork to middle of margin.

Oligocene: Gurnet Bay (Brodie). More perfect material may indicate a distinct genus. The species is very different from *S. relicta* Hagen and *S. amissa* Hagen, found in Baltic amber. The specimen is in the British Museum (I. 8644.) A wing of the ant *Oecophylla atavina* Cockerell is on the same small piece of rock.

HYMENOPTERA.

TAENIURITES, new genus (Tenthredinidae).

Body elongated, parallel-sided, the abdomen bandlike, the middle segments more than twice as broad as long; head rather small; antennae long, not very slender; hind femora inserted beneath third abdominal segment, short, not reaching beyond fifth. Anterior wings with costal cell distinct, the transverse vein stout, oblique, a little basad of insertion of basal nervure, as in MacGillivray's figure of *Macrophya*; basal nervure inserted far from origin of cubital (as in *Hoplocampa*); basal and first recurrent nervures parallel; marginal cell with cross-vein arched upward or outward (as in *Macrophya*), inserted near beginning of last third of third submarginal cell; second submarginal cell very long, receiving first recurrent nervure a short distance before middle; third submarginal greatly broadened apically, with the lower apical corner produced (style of *Macrophya*); median vein (cubitus) bent or angled at origin of basal nervure, its basal part straight (style of *Stromboceros*); basal nervure some distance basad of transverse-median (as in *Stromboceros*); second discoidal cell with its side on first discoidal much longer than that on third (as in *Macrophya*); lanceolate (anal) cell without any cross-nervure, narrowed subbasally by the upward bending of its lower nervure, the bend gradual, not at all abrupt. Hind wings with the lower apical corner of the median cell just before the end of the broad anal (as in *Strongylogaster*), but the upper apical corner more produced (as in

Emphytus); end of subcostal cell (media of MacGillivray) produced, its face on radial longer than that on discoidal, that on cubital very short (style of *Macrophya*); cubital very long, receiving second recurrent nervure well before its middle (approach to condition of *Macrophya*).

In the tables by MacGillivray, Rohwer, etc., this runs positively to Selandriinae, and on account of the form of the body falls in the division Strongylogasterini (Strongylogasterinae of Ashmead). On the other hand, many details of the venation are like those of *Macrophya*, to which the insect runs in Cresson's table, except as to the character of the hind legs. The genus, therefore, seems to combine the characters of the Selandriinae and Tenthredininae, and to lend support to Ashmead's opinion that the Strongylogasterinae should be associated with the latter rather than with the true Selandriinae.

Type of the genus.—*Taeniurites fortis*, new species.

TAENIURITES FORTIS, new species.

Plate 31, fig. 14.

Length, 14 mm.; anterior wing, 11 mm.; antennae, about 6 mm.; width of abdomen, 3.7 mm.; head and thorax black; abdomen apparently reddish, infuscated apically; wings hyaline. The following measurements are in microns: Anterior wings: First marginal cell on third submarginal, 1,056; second marginal on third submarginal, 336; basal nervure on first discoidal, 864; end of basal to beginning of cubital, 849; first submarginal on first discoidal, 800; second submarginal on first discoidal, 704; second submarginal on third discoidal, 1,040; third submarginal on third discoidal, 544; lower side of third submarginal beyond second recurrent nervure, 1,136; second discoidal on first, 1,616, and on third, 800. Hind wing: Cubital cell on discoidal, 880; lower side of cubital beyond discoidal, 1,170.

Florissant, Miocene shales.

Type.—Cat. No. 62542, U.S.N.M.

Among all the fossil sawflies from Florissant, this closely resembles only *Macrophya pervetusta* Brues, from which it is distinguished by the parallel-sided (not at all oval) abdomen and the form of the lanceolate cell.

HERIADES PRISCUS, new species (Megachilidae).

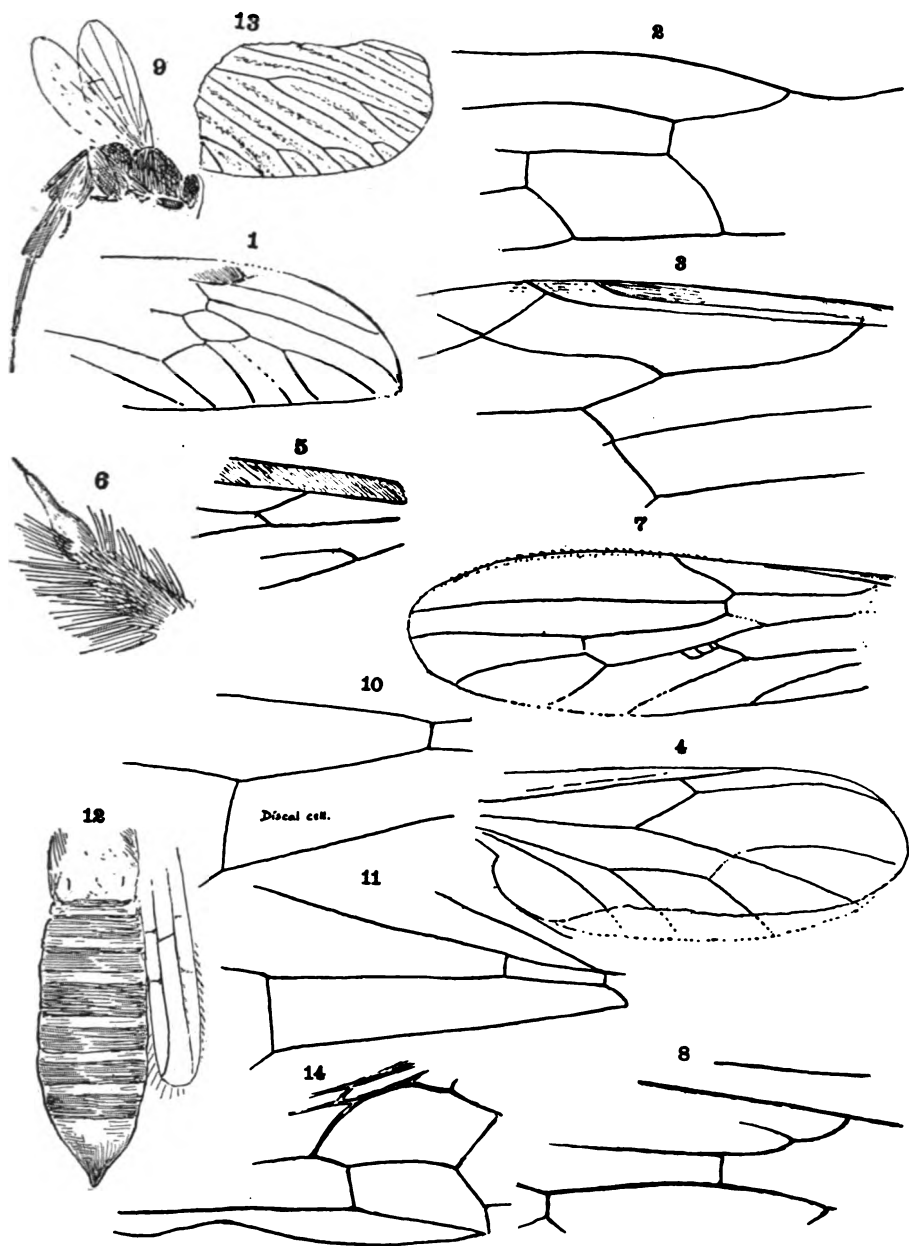
Female.—Robust, hairy, black, about 11.5 mm. long; anterior wing, 6 mm. or a little over; wings, hyaline; scape rather short, probably about 850 microns; flagellum thick, 240 microns broad near middle. Stigma well developed; two submarginal cells; second (morphologically third) transversocubital nervure with a double curve, its lower part strongly bulging outward; distance from end of second recurrent nervure to lower end of second transversocubital

less ($95\ \mu$) than distance from lower end of first transversocubital to insertion of first recurrent ($128\ \mu$),—a character of *Heriades* proper as against *Chelostoma*; second recurrent nervure with an even, gentle outward curve; lower end of basal nervure curved, and the transversomedian (which is $400\ \mu$ long) in a straight line with it, its upper part vertical, but the lower end curved basad, as is characteristic of *Heriades*. The following measurements are in microns: Width (depth) of stigma, 160; width (depth) of marginal cell, 368; marginal cell on first submarginal, 320, and on second, 448; total length of second submarginal cell, 850; first submarginal cell on basal nervure, about 288, and on first discoidal cell, 816; second submarginal cell on third discoidal, 672; basal nervure on first discoidal cell (not allowing for curve), 752.

Florissant, in the Miocene shales. The largest Florissant *Heriades*.
Type.—Cat. No. 62543, U.S.N.M.

EXPLANATION OF PLATE 31.

- FIG. 1. *Tipula gardneri*, new species. Oligocene, Gurnet Bay, Isle of Wight.
 2. *Riphiidia brodiei*, new species. Discal cell and adjacent parts. Oligocene, Gurnet Bay, Isle of Wight.
 3. *Mongoma cruciferella*, new species. Oligocene, Gurnet Bay, Isle of Wight.
 4. *Bibio gurnetensis*, new species. Oligocene, Gurnet Bay, Isle of Wight.
 5. *Bibio oligocenus*, new species. Oligocene, Gurnet Bay, Isle of Wight.
 6. *Acreotrichites scopulicornis*, new species. Antenna. Miocene (Florissant), Florissant, Colorado.
 7. *Mesomyites concinnus*, new species. Oligocene, Gurnet Bay, Isle of Wight.
 8. *Rhamphomyia hypolitha*, new species. Miocene (Florissant), Florissant, Colorado.
 FIGS. 9, 10. *Uortalis caudatus*, new species. 10. Discal cell and adjacent parts. Miocene (Florissant), Florissant, Colorado.
 FIG. 11. *Protoscinia perparvus*, new species. Discal cell and adjacent parts. Oligocene, Gurnet Bay, Isle of Wight.
 12. *Aeolothrips brodiei*, new species. Oligocene, Gurnet Bay, Isle of Wight.
 13. *Sisyra* (?) *disrupta*, new species. Oligocene, Gurnet Bay, Isle of Wight.
 14. *Taeniurites fortis*, new species. Lanceolate cell, etc., of anterior wing. Miocene (Florissant), Florissant, Colorado.



NEW FOSSIL INSECTS FROM THE TERTIARY.

FOR EXPLANATION OF PLATE SEE PAGE 384.

NEW SPECIES OF SOUTH DAKOTA CRETACEOUS CRABS.

By MARY J. RATHBUN,

Associate in Zoology, United States National Museum.

The fossil crabs described below were sent to the United States National Museum for identification by Mr. W. H. Over, of the University of South Dakota, Vermilion, South Dakota. They were collected by Mr. Over in the Pierre Shales, partly at Indian Creek, Pennington County, in the summer of 1914, but chiefly at Eastern, Corson County, in the summer of 1915.

The most numerous form represents a new type of Dromiacean for which it is necessary to construct a new superfamily. The two remaining species are referred to known genera.

The type-specimens have been given to the United States National Museum, while duplicates are in the collection of the University of South Dakota.

Tribe BRACHYURA.

Subtribe DROMIACEA.

In this subtribe the oviducts perforate the coxae of the second pair of ambulatory legs, while the seminal ducts perforate the coxae of the last pair of legs. The last pair of legs are dorsal in position and nearly always prehensile, slender, and reduced in size.

DAKOTICANCROIDEAE, new superfamily.

Sternum of female without longitudinal grooves. Eyes sheltered by orbits when retracted. No *lineae anomuricae*.

This superfamily is made necessary, because the species here described can not be placed in the Dromioideae, in which the sternum of the female has longitudinal grooves, nor in the Homoloideae, in which the eyes are incompletely or not at all sheltered by orbits, and *lineae anomuricae* are nearly always present.

DAKOTICANCRIDAE, new family.

Same characters as those of the superfamily.

DAKOTICANCER, new genus.

Carapace transverse, thick, deeply grooved. Front, between the eyes, small. Orbits well defined; eyes small, tapering. Outer max-

illipeds broad and flat, but advanced beyond the front. Chelipeds elongate, merus large, palm small, fingers ¹ very long. Last leg very small, subdorsal.

DAKOTICANCER OVERANA, new species.

Plate 32; plate 33, figs. 6-14.

Type-locality.—South Dakota: Indian Creek, Pennington County; Pierre Shale; Upper Cretaceous; August, 1914; W. H. Over; two specimens, holotype and paratype, presented by the University of South Dakota, Vermilion, South Dakota.

Holotype.—Cat. No. 32055, U.S.N.M.

Additional material.—More than 80 specimens were collected at Eastern, Corson County, South Dakota, in the Pierre Shales, by W. H. Over, July, 1915. Most of these are in the University of South Dakota, but a series of 30 have been presented to the United States National Museum.

Measurements.—Holotype, width of carapace, 30.2; approximate length, 26; approximate thickness, 10; width between the outer angles of the orbits, 15.4 mm.

Description.—There is no complete specimen even of the carapace, so that this description is a composite from a number of specimens. Carapace thick, transversely suboblong; gastro-cardiac area separated by a deep and angled groove from the branchial and hepatic regions, which are deeply separated from each other; a broad, deep, transverse branchial groove is continued forward on the nearly vertical side-wall of the carapace toward the buccal angles; a broad, shallower groove furrows the side-wall just below the hepatic region; a depression follows the posterior and lateral margins of the carapace just within the edge. The most elevated portions are covered with small granules; the intermediate areas, comprising the greater part of the surface, are smooth and finely punctate; the longitudinal, granulated band on the gastro-cardiac is not interrupted by the narrow, shallow groove which separates those two regions from each other. The inner angle of the branchial region is prolonged backward and inward in a narrow, raised peninsula, nearly surrounded by deep impressions and pits. The anterior part of the carapace is divided by shallow depressions into longitudinal areoles, four on either side of the middle, of which two are gastric and two hepatic. Posterior margin granulate and slightly arched, meeting the side margin at a rounded angle.

¹ The character of the fingers is given with a reservation. Of the many specimens taken, only one shows a trace of fingers, and these exhibit such an unusual shape that although they are in the position where one expects fingers, i. e., bent against the arm, it may later be proven that they are, for example, merus joints of ambulatory legs. On the other hand, the fragility resulting from their great length and relative slenderness may account for the destruction of all the fingers which this large collection of crabs possessed.

Front deflexed, subtriangular, broader than long, bilobed at extremity, medially grooved, sides elevated, granulate.

Orbits inclined forward and outward and, in front view, downward; divided into two sockets, the inner one the larger, and with a spine on its lower border. Eyes reaching very little into the second socket and tapering distally.

One joint of the antennule is seen just below the origin of the eye and has granulated edges.

Outer maxillipeds only partially shown. Exognath half as wide as endognath, of which only the ischium is visible and that has the end broken off. Even so, it reaches forward beyond the line of the rostrum. There appears to be a space between the two maxillipeds. Their edges are finely granulated.

Chelipeds over twice as long as carapace. Merus massive, a little compressed, widest at the middle, granules in several rows on the margins, scarce elsewhere. Carpus slightly longer than wide, outer or upper surface granulate, with a longitudinal groove through its middle, inner margin spinulose. Palm nearly as high as its superior length, granules arranged irregularly in wide lengthwise bands, and more spinulose than elsewhere. Fingers elongate, two or three times as long as palm, compressed, granulate about the edges. The fingers themselves are not preserved, but only their impression.

Only the proximal portions of the ambulatory legs can be made out. First three pairs similar and of good size; the ischium and merus joints are granulate, and the latter are compressed. The last pair are slender and much reduced in length and are probably subdorsal; very little of them remains except the first segment.

Most of the specimens showing the ventral surface are males, but five are females. The genital ducts are to be seen at the base of the fifth pereopods in the male, of the third in the female. The sternal segments are granulate through the middle; the first segment bears a transverse depression. The abdomen is composed of seven separate segments in both sexes; in the male it is oblong with the sides somewhat convergent, in the female it is subovate.

Relationships.—This form approaches *Polycnemidium pustulosum* Reuss from the Cretaceous of Bohemia,¹ in the areolation of the carapace and the extent of the fronto-orbital region, but the latter has the carapace more strongly convergent posteriorly and nothing is known of its appendages.

¹ Denk. k. Akad. Wiss., math.-natur. Cl., vol. 17, 1860, p. 6, pl. 3, fig. 1.

Superfamily HOMOLOIDEAE.

Family HOMOLIDAE.

Genus HOMOLOPSIS (Carter, MS.) Bell.

Homolopsis BELL, Mono. Foss. Malac. Crust. Gr. Britain, pt. 2, 1862, p. 22.

HOMOLOPSIS PUNCTATA, new species.

Plate 33, figs. 1-3.

Type-locality.—South Dakota: Eastern, Corson County; Pierre Shale; Upper Cretaceous; July, 1915; W. H. Over; one specimen, holotype, presented by the University of South Dakota, Vermilion, South Dakota.

Holotype.—Cat. No. 32058, U.S.N.M.

Measurements.—Length of carapace of holotype, 19; width (estimated), 25 mm.

Description of holotype.—Carapace only, with a longitudinal break on each side across the entire length. The posterior two-thirds is fairly level except toward the side margins, but the anterior third curves strongly downward. The grooves separating the gastric and cardiac regions from the branchial region, and the epibranchial from the mesobranchial lobe, and those limiting the hepatic region are very deep. Much shallower grooves limit the mesogastric and urogastric regions, and the mesobranchial lobe posteriorly. The surface of the carapace is finely and uniformly punctate except on the elevated portions, which are roughened with fine uneven granules, many of which on the posterior part of the carapace are combined in short transverse lines. The elevations form, in the main, regularly placed bosses or areoles well separated; four of these bosses are on the mesogastric region, two being median and two transverse and side by side at the widest part; there is one boss on each epigastric lobe, and three large and one small on each protogastric lobe; two large and one small boss on each epibranchial lobe. The cardiac region has one large flat elevation, subtriangular, widest in front. The mass of granules on the mesobranchial lobe is transversely oblique, following the shape of the lobe. On the metabranchial lobes the granules are more scattered and less elevated than elsewhere.

The front between the eyes is equilaterally triangular, strongly bent down, surface concave, tip apparently blunt. There are two tubercles or spines (broken off) on the upper border of the orbit, besides one at the outer angle.

On the lateral margin there is a small spine not far from the orbit, a large spine and two or three small ones on the hepatic region, and two (one below the other) on the epibranchial lobe.

Posterior margin bordered by a thin raised granulated rim.

Relationships.—This species has considerable resemblance to *H. edwardsii*¹ Bell, the type-species of the genus, but in the latter, the protogastric lobes are each partially separated from the metagastric lobes by a deep, transversely oblique furrow, the cardiac region bears a small tubercle at its middle, the surface is everywhere granulated.

H. depressa Carter,² from the same localities as *edwardsii*, is also granulated throughout and lacks the large areolar tubercles of *punctata*.

Our species is near *H. transiens* Segerberg³ from the Cretaceous of Denmark, which however, has no large mesogastric tubercles, and has three instead of four tubercles on each protogastric lobe.

H. richardsoni Woodward,⁴ from the Cretaceous of British Columbia, and *H. japonica* Yokoyama,⁵ from the early Tertiary of Japan, have a carapace much narrower anteriorly than those above mentioned. They should probably be referred to a distinct genus.

Subtribe OXYSTOMATA.

? Family CALAPPIDAE.

Genus CAMPYLOSTOMA Bell.

Campylostoma BELL, Mono. Foss. Malac. Crust. Gr. Britain, pt. 1, 1857, p. 23.

CAMPYLOSTOMA PIERRENSE, new species.

Plate 33, figs. 4–5.

Type-locality.—South Dakota: Eastern, Corson County; Pierre Shale; Upper Cretaceous; July, 1915; W. H. Over; two specimens, holotype and paratype, presented by the University of South Dakota, Vermilion, South Dakota.

Holotype.—Cat. No. 32057, U.S.N.M.

Description of holotype.—An incomplete carapace, showing dorsal surface and an indication of the extent of one orbit. The orbit has a somewhat dorsal inclination, is slightly acutangled externally and has a tooth on the upper margin. The outer surface of shell, where it persists, is finely granulate. Spines conical. Five spines in a transverse row on the gastric region, which arches upwards toward the middle; row not quite straight, but slightly concave forward; distance from the middle spine to those of the submedian pair less than from the latter to those of outer pair. A median ridge runs back to the hinder border of the cardiac region, and bears five spines,

¹ Mono. Foss. Malac. Crust. Gr. Britain, pt. 2, 1862, p. 23, pl. 5, figs. 1 and 2. From the Gault at Folkestone and the Greensand at Cambridge.

² Quart. Journ. Geol. Soc. London, vol. 54, 1898, p. 22, pl. 1, fig. 5.

³ Geol. Förel. i Stockholm Föreländl., vol. 22, 1900, Häfte 5, p. 366, pl. 8, figs. 6–8. Also, Woodward, Geol. Mag., London, new ser., dec. 4, vol. 8, 1901, p. 499.

⁴ Quart. Journ. Geol. Soc. London, vol. 52, 1896, p. 224, text-fig. 2.

⁵ Journ. Coll. Sci. Imper. Univ. Tokyo, vol. 27, 1911, art. 20, p. 12, pl. 3, fig. 4.

viz, one mesogastric, besides the one above mentioned, one urogastric, two cardiac; the anterior of the gastric spines is the largest of all. On the inner branchial region there is a short, nearly longitudinal ridge, inclining a little inward anteriorly, and bearing a spine at each end, the posterior spine the larger; on the right side there is a small, low spine on the anterior slope of the posterior spine; this accessory spine is wanting on the left side. A short but high, oblique ridge runs to the postero-lateral margin, rises in a low spine anteriorly and terminates posteriorly in a strong spine which points backward and outward, but is broken off at base. Short, low, obliquely transverse ridges lead to two other lateral spines. All the lateral marginal spines are broken off close to their origin. They appear to be four in number, and with an hepatic and an outer orbital spine form an almost semicircular row of six spines. The pterygostomian region is produced well beyond the first of these spines and bears a spine which is a little in advance of the angle of the orbit.

Description of paratype.—Smaller than holotype, with all spines broken off, and with rostrum visible; this is small, triangular, surface concave, with a deep, longitudinal furrow, tip rounded.

Measurements.—Estimated width of carapace of holotype, at widest part, in front of middle, 28 mm. Width of paratype at same point, 18.6 mm.; approximate length of same, 20 mm.; width across front and orbits, 8.6 mm.

Relationships.—This species resembles *C. matutiforme* Bell,¹ the type-species of the genus, from the London Clay (Eocene) of the Isle of Sheppey, England, in the presence of spines or tubercles on the dorsal surface and spines on the margin. In *pierreense* the spines are more numerous (6 marginal instead of 5), the front is simple instead of bifid, and the pterygostomian region is much more prominent.

As the specimens in hand show none of the appendages, I am unable to improve upon the present grouping of this genus in the Matutinae. The obliquely vertical surface in front of and below a line drawn between the outer orbital spine and the pterygostomian or subhepatic spine, is suggestive of the concave suborbital surface in many species of *Hepatus*.² A prominent subhepatic spine exists often in the Oxyrhyncha, as in our common spider crabs, *Libinia*.³

¹ Mono. Foss. Malac. Crust. Gr. Britain, pt. 1, 1857, p. 23, pl. 3, figs. 8-10.

² Latreille, Hist. Nat. Crust., vol. 3, year 10 (1801-2), p. 22.

³ See Proc. U. S. Nat. Mus., vol. 15, 1892, pl. 31, figs. 1, 2; the marginal spine behind the orbit is on a much lower level than the succeeding spines.

EXPLANATION OF PLATES.

(Figures enlarged nearly 1½ times.)

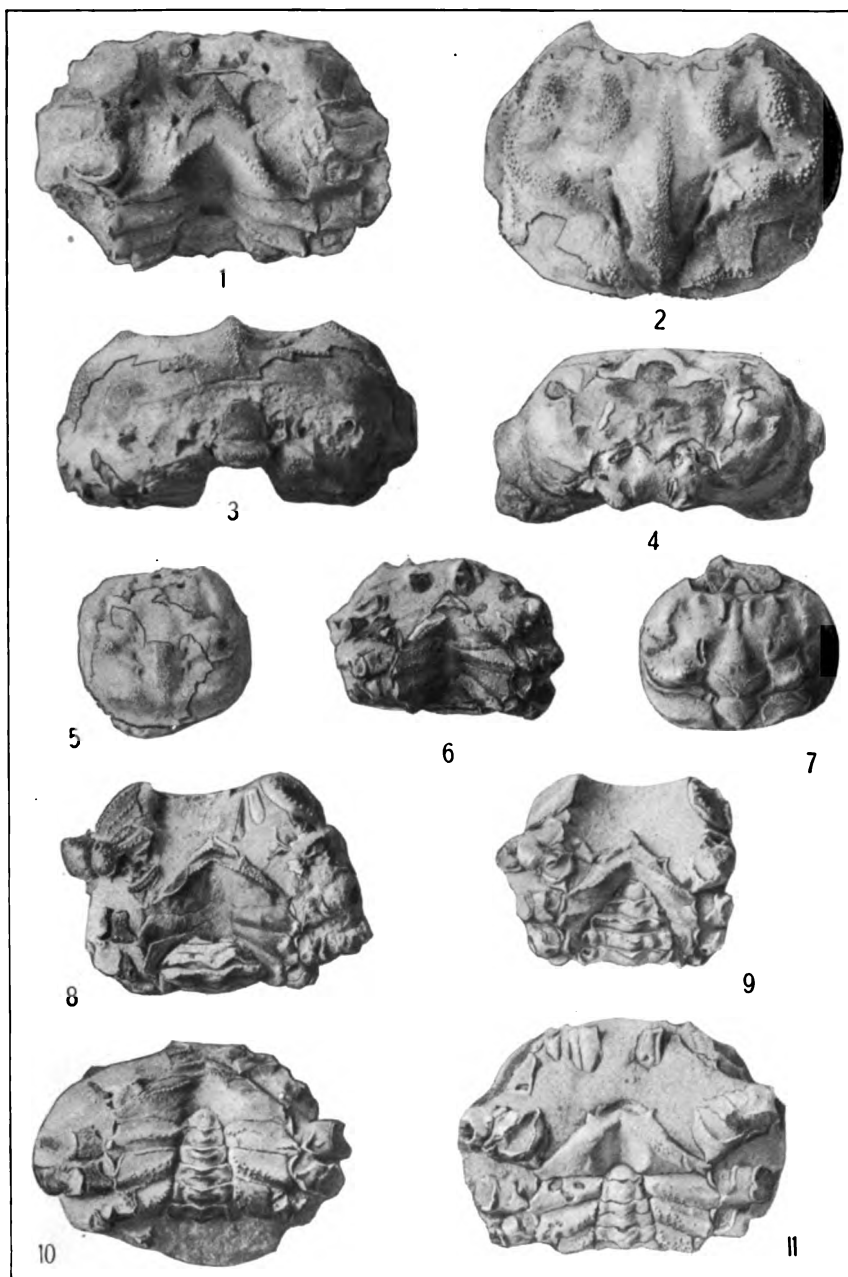
PLATE 32.

Dakoticancer overana.

- FIG. 1. Holotype, male, ventral view.
 2. Holotype, male, dorsal view.
 3. Holotype, male, posterior view, showing bases of hind legs and genital ducts.
 4. Paratype *b*, male, anterior view, showing eyes.
 5. Paratype *a*, dorsal view, showing part of posterior margin of carapace.
 6. Paratype *l*, ventral view, showing sternum of female.
 7. Paratype *h*, dorsal view, to show outline of front.
 8. Paratype *d*, ventral view, showing genital ducts of female.
 9. Paratype *c*, ventral view, showing abdomen of female.
 10. Paratype *e*, ventral view, showing abdomen of male.
 11. Paratype *b*, ventral view, showing portion of maxillipeds.

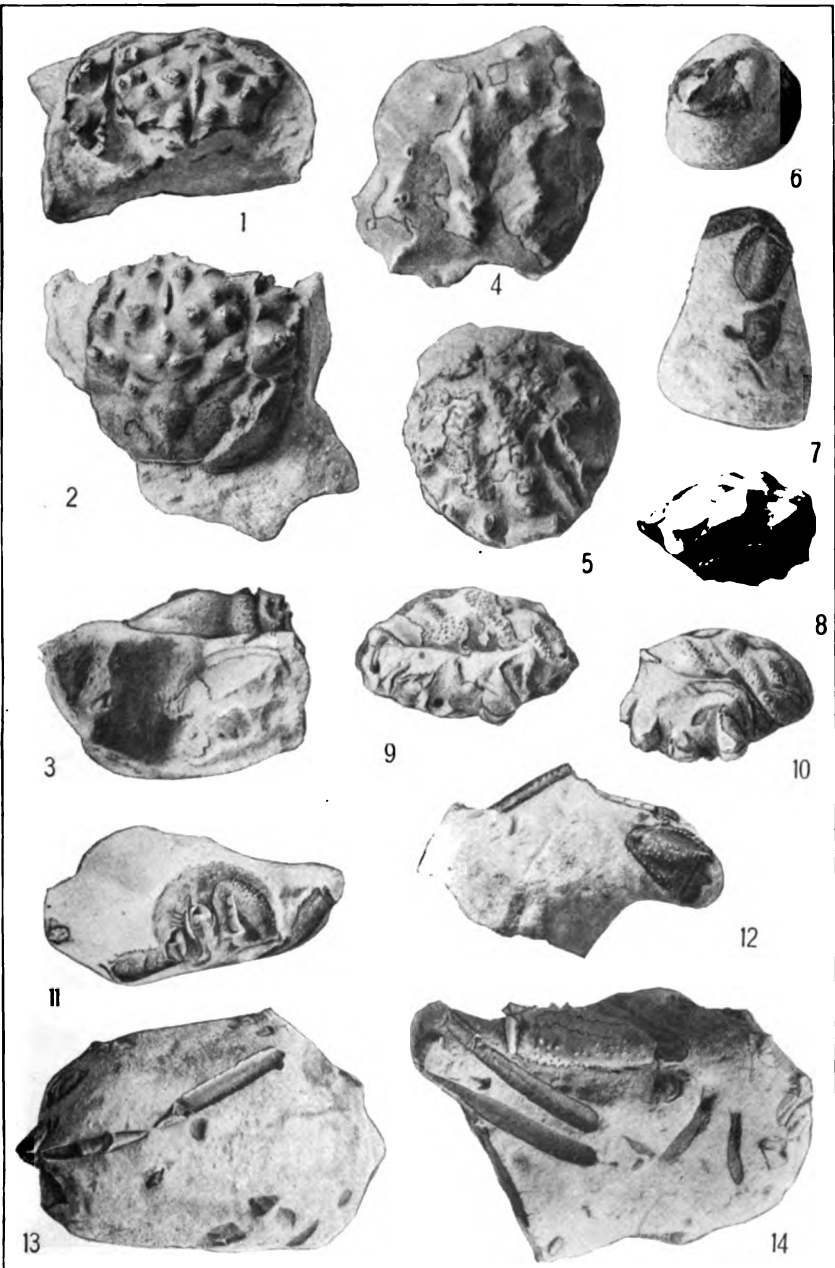
PLATE 33.

- FIGS. 1-3. *Homolopsis punctata*, holotype. 1. Anterior view. 2. Dorsal view. 3. Right side, in profile.
 4-5. *Campylostoma pierrense*. 4. Holotype, dorsal view. 5. Paratype, dorsal view.
 6-14. *Dakoticancer overana*.
 FIG. 6. Paratype *f*, manus.
 7. Paratype *f*, cheliped (merus, carpus, manus).
 8. Paratype *h*, left side of carapace, in profile.
 9. Paratype *d*, right side, in profile.
 10. Paratype *c*, right side, in profile.
 11. Paratype *g*, carpus of cheliped.
 12. Paratype *g*, manus.
 13. Paratype *k*, extremities of two ambulatory legs.
 14. Paratype *j*, cheliped (merus and impressions of fingers).



NEW SOUTH DAKOTA CRETACEOUS CRABS.

FOR EXPLANATION OF PLATE SEE PAGE 391.



NEW SOUTH DAKOTA CRETACEOUS CRABS.

FOR EXPLANATION OF PLATE SEE PAGE 391.

DIAGNOSES OF NEW SPECIES OF MARINE BIVALVE MOLLUSKS FROM THE NORTHWEST COAST OF AMERICA IN THE COLLECTION OF THE UNITED STATES NATIONAL MUSEUM.

By WILLIAM HEALEY DALL,

Honorary Curator of Mollusks, United States National Museum.

Having in preparation a check list of the bivalve mollusks contained in the marine fauna of the region including the coasts from Point Barrow in the Arctic to San Diego, California, it was found that a comparatively large number of the species in the collection of the United States National Museum were undescribed.

To avoid launching into the literature a quantity of manuscript names the present diagnoses have been prepared. It is hoped at no very distant date to furnish fuller data concerning these species, including suitable figures.

In the descriptive matter following, when a station number is given it refers always to the number of a dredging station of the United States Fisheries Steamer *Albatross*. The data relating to these stations have been printed by the Bureau in its Bulletins. Those species not referred to a station number were collected by private persons, including the writer, at various times during the last sixty-five years, one species having been picked up by Major Rich during the Mexican War.

The typical specimens are all preserved in the collection of the United States National Museum. Had the undescribed species belonging to the more southern fauna now in the collection been included, the number would certainly have been greatly increased. These forms, however, are reserved for treatment later.

In the descriptions when the beaks are said to be a certain distance behind the end of the shell, the distance is measured from a vertical line dropped from the umbo to the basal margin, and at the level of the most distant point of the end of the shell referred to. This vertical line indicates the height, the length being measured on a horizontal line parallel with the base of the shell in a general sense. The diameter is the maximum distance from the outside of one valve to the outside of the other, taken at right angles to the vertical plane of the valves. Measurements are all in millimeters.

NUCULA CARDARA, new species.

Shell polished, light olive-green, thin, elongate-oval, with 8 anterior and 18 posterior prominent teeth, the resilifer prominent and largely free from the hingeline, the interior very pearly, the valve-margin smooth, the beaks hardly prominent, situated 5 mm. behind the anterior end of the shell and showing the whitish prodissoconch. Length, 16; height, 11.5; diameter, 8 mm. Cat. No. 265905, U.S.N.M. Station 5673, in 1090 fathoms, mud, off San Diego, California.

This elegant shell has no sculpture except incremental lines which are hardly visible, but toward the margin become strong at intervals, but without regularity. The periostracum near the beaks becomes dark, and in the closed shell suggests *Malletia*. There is no lunular boundary around the subumbonal depression.

NUCULA DARELLA, new species.

Shell small, inflated, subtriangular, the anterior end slightly shorter; periostracum dark olive, the surface smooth except for somewhat irregular, inconspicuous incremental lines, but under a lens showing faint close radial striae; lunule large, distinctly limited by an impressed line, mesially with a slight pout; about five anterior and eight posterior hinge teeth, the resilifer deep, small, central, not projecting; inner margins of the valves sharply radially grooved; beaks pointed, showing the prodissoconch plainly. Length, 4; height, 3; diameter, 2.7 mm. Cat. No. 111424, U.S.N.M.

Station 2923, 822 fathoms, off San Diego, California.

NUCULA LINKI, new species.

Shell small, inflated, smooth, dark olive, very inequilateral, subtriangular, the anterior end shorter; lunule large, bounded by a faint keel; beaks prominent showing the whitish prodissoconch; six anterior and eleven posterior hinge teeth; valve-margin entire; the resilifer small, deeply set, subumbonal, not projecting. Length, 6; height, 5; diameter, 3.6 mm. Cat. No. 107649, U.S.N.M.

Station 3034, 24 fathoms, mud; off Point Fermin, Lower California.

NUCULA QUIRICA, new species.

Shell small, dark olive inclining to black, polished, with rather rude irregular incremental lines; rounded triangular, the anterior end very short; valves inflated with seven anterior and twelve posterior hinge-teeth, the resilifer narrow, elongated, very oblique, almost parallel with the posterior dorsal margin, hardly projecting; inner margin of the valves entire; beaks prominent showing the prodissoconch, lunule obscure. Length, 8; height, 6; diameter, 3.5 mm. Cat. No. 208727, U.S.N.M.

Chugachik Bay, Cooks Inlet, Alaska, in 60 fathoms, gravelly bottom.

NUCULA PETRIOLA, new species.

Shell minute, ovate, inflated, the form resembling *Crenella columbiana*, the prodissoconch visible on the rather inflated beaks; lunule obscure; color greenish olive, smooth and polished; valve margins smooth, hinge line very short. Length, 1.25; height, 2; diameter, 1.5 mm. Cat. No. 271416, U.S.N.M.

Off Santa Rosa Island, California, in 53 fathoms, mud. The solid shell and inflated form of this minute *Nucula* seem to indicate that it is not an immature shell.

LEDA NAVISA, new species.

Shell elongate, arcuate, inequilateral, with slender recurved rostrum and well-marked smooth impressed escutcheon but no lunule; base convexly arcuate, rostrum obliquely truncate, anterior end evenly rounded; beaks obscure, 5.5 mm. from the anterior end; sculpture of numerous sharp concentric low ridges, with wider flat interspaces, obsolete toward the rostrum; anterior teeth about twelve, posterior about twenty, the resilifer minute, subumbonal, not projecting; interior chalky, a small medial ridge near the end of the rostrum. Height, 7; length, 16; diameter, 5 mm. Cat. No. 208770, U.S.N.M.

Off the Farallones Islands, California, in 191 fathoms, sand; bottom temperature 44°. 5.

LEDA AMIATA, new species.

Shell light olivaceous, elongate, compressed, the posterior dorsal margin nearly straight; beaks low, polished, about 3.5 mm. from the anterior end, showing the whitish prodissoconch; the smooth surface continues for a short distance when the sculpture changes to sharply evenly lamellose with slightly larger interspaces wider on the rostral area which is defined by the angular turn of the lamellae which stop short at the sharp margin of the long impressed escutcheon; interior porcellaneous, with twelve anterior and sixteen posterior teeth, the resilifer minute, subumbonal, hardly projecting. Length, 11.3; height, 4.5; diameter, 3.0 mm. Cat. No. 209252, U.S.N.M.

Station 4351, off San Diego, California, in 488 fathoms, muddy bottom. This elegant shell recalls *L. constellata* of the Panama fauna, but the rostrum is more simply sculptured.

LEDA OXIA, new species.

Shell minute, rounded in front, very acute behind, the valve ending in a sharp point; base arcuate, beaks low, subcentral, dorsal slopes nearly straight; sculpture of regular, equal concentric ridges with subequal interspaces, a depressed ray from the beak to the base anteriorly, a deeply impressed, concentrically striated escutcheon bordered by a rounded keel; lunule linear; about eight teeth on either

side of a minute resilifer. Length, 4.5; height, 3; diameter, 1 mm. Cat. No. 214448, U.S.N.M.

Station 2901, off Santa Rosa Island, California, in 48 fathoms, muddy bottom. This species is related to *L. commutata*.

LEDA LIOGONA, new species.

Shell small, light yellowish, concentrically sculptured with prominent elevated ridges with wider interspaces, except on the beaks where the prodissoconch is relatively large and perfectly smooth, the concentric sculpture commencing abruptly; beaks low, and about 3 mm. from the anterior end; base slightly arcuate, dorsal slopes direct, rostrum abruptly truncate; posterior dorsal area with two obscurely elevated rays over which the concentric sculpture is higher, but it becomes reduced to striation upon the strongly impressed escutcheon; teeth much crowded, about twelve posterior and about the same number in front of the minute subumbonal resilifer. Length, 9; height, 5.3; diameter, 3.3 mm. Cat. No. 214089, U.S.N.M.

Station 3604, Bering Sea, in 1401 fathoms, mud.

This species differs from the young of *L. radiata* Krause, by its more conspicuous and regular sculpture and by the absence of radiating threads. It probably attains a larger size.

LEDA FOSSA Baird, 1863.

Variety *sculpta* Dall. This form has regular concentric ripples on the beaks, behind a faint depressed ray near the anterior end and on the keels on either side of the escutcheon. Cat. No. 107688, U.S.N.M.

Station 2855, southeast of Alaska Peninsula, in 66 fathoms, mud.

Variety *vaginata* Dall. This differs from the last in having the concentric sculpture finer and less evident, and spread over the entire shell. Cat. No. 226072, U.S.N.M.

Station 4244, at Kasa-an Bay, Alaska, in 50 fathoms, mud.

Variety *curtulosa* Dall. Shell resembling variety *sculpta* but relatively shorter than that or the typical form. Cat. No. 33771, U.S.N.M.

Unalaska Harbor in 60 fathoms on the Ridge.

LEDA GOMPHOIDEA, new species.

Shell elongate, inequilateral, smooth, polished, the rostrum obliquely rounded-truncate, the anterior side rounded and shorter; beaks small, but pustule like, 5 mm. from the anterior end, the prodissoconch distinct; teeth small and numerous, about 25 in front of and 35 behind the small oblique resilifer; posterior basal and dorsal margins nearly straight, the escutcheon narrow, long, impressed, and striated. Length, 17.5; height, 8; diameter, 4 mm. Cat. No. 212889, U.S.N.M.

Station 3346, off Tillamook Bay, Oregon, in 786 fathoms.

LEDA FIASCONA, new species.

Shell small, subtriangular, rounded, thin, dull olive, the anterior slightly shorter than the posterior end, the base arcuate; the posterior end attenuated, compressed, pointed; sculpture of fine concentric threads, close set and covering the anterior two-thirds of the valves, stopping abruptly at the posterior third where the compression begins; beaks not prominent, a small and narrow lunule and escutcheon indicated; hinge with 8 anterior and about 4 posterior teeth, the resilifer small, subumbonal, not projecting. Length, 4; height, 2.7; diameter, 1.7 mm. Cat. No. 215597, U.S.N.M.

Station 2923, off San Diego, in 822 fathoms, mud.

LEDA PHENAXIA, new species.

Shell small, solid, plump, smooth except for faintly evident incremental lines and delicate radial striulae; periostracum dark olive, immediately under the beaks blackish for a short distance; base evenly arcuate, dorsal slopes nearly straight; beaks nearer the anterior end, full, not pointed, with a short-cordate lunular impression and narrow, elongate escutcheon, neither defined by any sharp boundary; hinge very strong for the size of the shell, with about 8 or 9 long teeth on each side of a rather small strong resilifer. Length, 4.5; height, 3.5; diameter, 1.3 mm. Cat. No. 215596, U.S.N.M.

Station 2923, off San Diego, California, 822 fathoms, mud.

The short blackish patch of periostracum directly between the beaks gives this little shell the aspect of a *Tindaria*, and the strong hinge makes the shell very difficult to open, but the ligament is strictly internal.

LEDA SPARGANA, new species.

Shell small, elongate, inequilateral, pale olivaceous, compressed; prodissoconch conspicuous, otherwise the beaks are low, and about 4 mm. from the anterior end of the shell; sculpture of low concentric ridges, stronger anteriorly, sparser toward the beaks, and obsolete on the dorsal area behind; there is an obscure radial depression anteriorly, and two obscure radial ridges on each side of the impressed escutcheon where the dorsal margin of the valves is prominently elevated; there are about 12 anterior and 18 posterior teeth, the resilifer is small, rotund, and subumbonal; there is a small mesial ridge near the end of the rostrum internally. Length, 12; height, 5; diameter, 2.6 mm. Cat. No. 208897, U.S.N.M.

Station 4367, off Point Loma, San Diego County, California, in 215 fathoms, mud.

LEDA HAMATA Carpenter, 1864.

Variety *limata* Dall. In this variety the valves have the same profile as in the typical form but the strong concentric sculpture, which is so uniform in the northern specimens of this species, is subject to

extraordinary mutations, which taken alone would appear to represent perfectly distinct species. In the extreme form of this variety the surface of the disk is perfectly smooth. In another mutation there are a few very coarse concentric ridges near the umbones. In still another the umbonal region is smooth and the ridges appear near the basal margin only. The keels on the rostrum in typical *limata* are plain, in other specimens there may be successive prominent concentric ridges rising into pustules where they intersect the keels. Almost every combination of these characters may be found in a large series of the species. These fluctuations appear to be connected with the southern habitat, being most violent in specimens collected at La Paz, just inside the Gulf of California. A somewhat similar series of mutations has been noticed in one of the species from the Miocene of Virginia. Cat. No. 211292, U.S.N.M.

Station (of the typical specimens) 2902, off Santa Rosa Island, California, in 50 fathoms.

YOLDIA OLEACINA, new species.

Shell small, plump, smooth except for faint incremental lines, brilliantly polished, of a bright yellow brown with a slight olivaceous tint toward the beaks; egg-ovate, rounded and broader in front, attenuated behind; base broadly arcuate, dorsal margin gently curved; beaks low, 6 mm. from the anterior end; no defined lunule or escutcheon; 13 anterior and 11 posterior hinge teeth, the resilifer subumbonal, cup-like; the pallial line has a slight shallow sinus near the posterior adductor scar. Length, 16; height, 9; diameter, 6 mm. Cat. No. 223407, U.S.N.M.

Arctic Ocean north of Bering Strait, Captain Healy.

This brilliant species recalls several of the Arctic species, but does not exactly agree with any of them.

YOLDIA SECUNDA, new species.

Shell large, thin, inequilateral, inflated, subtruncate and recurved behind; color of a light grayish olive, more or less disposed in zones; this shell much resembles *Y. thraciaeformis* Storer, though it does not attain so great a size; it differs by the absence of the oblique elevated posterior ray from the umbones, in being more attenuated behind, and in general more cylindrically inflated; the valves hardly gape in front, and less behind than in that species; the hinge teeth are more numerous and smaller than in *thraciaeformis* of the same length. There are 24 anterior and 20 posterior teeth, the resilifer is similar to but smaller than in the species referred to above, which has 20 anterior and 10 posterior teeth in a valve of the same length. Length, 39; height, 22; diameter, 14 mm. (Cat. No. 107688, U.S.N.M.)

Station 3077, in Clarence Strait, Alaska, in 322 fathoms, mud.

YOLDIA BERINGIANA, new species.

Shell large, thin, smooth, except for lines of growth, brilliantly polished, inequilateral, hardly rostrate, rounded at each end, less compressed behind than *Y. secunda*; color a rich yellowish brown, slightly olivaceous near the umbones; valves closing completely; escutcheon striated, narrower than in *secunda*; beaks very low, 24 anterior and 17 posterior teeth, the resilifer ample, cup-shaped, projecting. The pallial sinus is rather large and rounded. Length, 40; height, 22; diameter, 16 mm. Cat. No. 226195, U.S.N.M.

Station 3607, Bering Sea, off the Pribiloff Islands, in 987 fathoms, mud.

YOLDIA ORCIA, new species.

Shell small, thin, pale olive, brilliantly polished, smooth, equilateral; base deeply arcuate; beaks not prominent, the posterior end slightly compressed, pointed and attenuated, the anterior end rounded; hinge with 8 anterior and 6 very minute posterior teeth, the resilifer subumbonal, extremely small. Length, 4.5; height, 3.5; diameter 2 mm. Cat. No. 111420, U.S.N.M.

Station 2923, off San Diego, California, in 822 fathoms, mud.

This species has no indication of lunule or escutcheon.

YOLDIA SANESIA, new species.

Shell small, thin, plump, pale olivaceous, inequilateral, the anterior end shorter, the beaks 2.6 mm. behind it; base roundly arcuate, dorsal slopes nearly straight, anterior end rounded, posterior end slightly recurved, compressed and bluntly rounded; beaks low, inconspicuous, with no indications of lunule or escutcheon; hinge with 7 or 8 very minute anterior and about 10 posterior teeth, the resilifer subumbonal and minute. Length, 6; height, 4; diameter, 2.5 mm. Cat. No. 223578, U.S.N.M.

Station 4224, in Boca de Quadra, Alaska, in 160 f fathoms, mud.

YOLDIA CECINELLA, new species.

Shell minute, polished, smooth, nearly equilateral, the margins arcuate above and below, the anterior end rounded, the posterior more pointed and slightly longer; beaks low and inconspicuous, with neither lunule nor escutcheon indicated; hinge with six or seven minute teeth on each side of the subumbonal, very small resilifer. Length, 5; height, 2.6; diameter, 1.5 mm. Cat. No. 211424, U.S.N.M.

Station 2823, off La Paz, Gulf of California, in about 26 fathoms.

This species is quite close to *Y. orcia*, but is uniformly less acute behind, smaller and more slender.

TOLDIA CAPSA, new species.

Shell very thin, small, polished, smooth, compressed, the beaks hardly rising above the general hingeline; base deeply arcuate, the dorsal margin very slightly convex; anterior end rounded, posterior end slightly broader and flatter, obscurely pointed toward the dorsal level; beaks slightly anterior to the middle line of the shell; hinge with a few very small anterior and posterior teeth; the resilifer subumbonal, not projecting. Length, 4.4; height, 3; diameter, 1.5 mm. Cat. No. 212499, U.S.N.M.

Station 3346, off Tillamook Bay, Oregon, in 786 fathoms.

MALLETTIA (MINORMALLETTIA) TALAMA, new species.

Shell large, thin, plump, of a uniform oval, with a brilliant, smooth, light yellowish-olive periostracum; beaks low, near the anterior third with about eight V-shaped teeth in front of them on the hingeline and about 36 much smaller teeth behind them; the latter are not obviously V-shaped, are very uniform in size and appearance; the hingeline is thickened under the anterior teeth, but the ligament is strictly external. The shell is slightly wider and more compressed behind the beaks but the difference is very small. Length, 23; height, 15; diameter, 10 mm. Cat. No. 225384, U.S.N.M.

Station 3603, off Pribiloff Islands, Bering Sea, in 1771 fathoms.

MALLETTIA (NEILO) FIORA, new species.

Shell small, thin, inequilateral, smooth, polished, pale olivaceous, somewhat compressed, the beaks at 4 mm. behind the anterior rounded end; the base evenly arcuate, the dorsal slopes nearly straight; near the posterior end the profile is obliquely attenuated above and below, terminating in a point; ligament distinctly external with about ten anterior and more numerous posterior teeth. Length, 10.5; height, 5.5; diameter, 3 mm. Cat. No. 207251, U.S.N.M.

Station 2859, southwest of Sitka Bay, Alaska, in 1,569 fathoms.

TINDARIA CALIFORNICA, new species.

Shell small, olivaceous, darker distally, inflated, smooth except for incremental lines, polished, swollen, inequilateral; beaks inconspicuous, with a large escutcheon bounded by an angle of the surface, but no lunule; anterior end rounded, plump, 4 mm. in front of the beaks; posterior end attenuated, bluntly rounded, and slightly recurved, the posterior dorsal slope being somewhat concave; the base evenly arched; hinge with 13 anterior and 18 posterior teeth; ligament strictly external, pallial sinus deep. Length, 10.5; height, 6; diameter, 4.5 mm. Cat. No. 96972, U.S.N.M.

Station 2840, off the Santa Barbara Islands, California, in 276 fathoms, mud.

TINDARIA BRUNNEA, new species.

Shell small, inflated, solid, subtriangular, of a warm yellow brown color; beaks large, prominent, with no distinguishable lunule or escutcheon, the ligament short but wholly external and behind the beaks; the surface sculptured with rather regular fine incremental lines which, toward the margin, appear almost like concentric ripples; there are also very faint radial lines on some parts of the shell; base arcuate, dorsal slopes nearly straight, anterior end rounded, posterior rather bluntly pointed; hinge with about eight anterior and fourteen posterior teeth. Length, 7.5; height, 6; diameter, 4 mm. Cat. No. 226333, U.S.N.M.

Station 3604, Bering Sea, in 1,401 fathoms.

The bright color distinguishes this from the other species at a glance.

TINDARIA MARTINIANA, new species.

Shell small, solid, olivaceous, inflated, subtriangular, inequilateral, the beaks nearer the anterior end; sculpture of fine concentric and still finer radial striae only visible under magnification; beaks full, incurved, 3.5 mm. from the anterior end, a small lanceolate lunule and a narrower and longer escutcheon are indicated only by the brown color of their areas against the pale olive of the shell; shell rounded in front, pointed bluntly behind, the base arcuate, the dorsal slopes nearly straight; hinge with 14 anterior and 16 posterior slender teeth, the ligament entirely external and posterior. Length, 8.6; height, 6.5; diameter, 5 mm. Cat. No. 207318, U.S.N.M.

Station 4425, off the Santa Barbara Islands, California, in 1,100 fathoms; also off Cape San Martin in 218 fathoms.

TINDARIA RITTERI, new species.

Shell small, plump, smooth except for incremental lines, brilliantly polished, pale olive, darker near the margin, rounded in front, inequilateral, slightly recurved, and bluntly pointed and attenuated behind; beaks low, ligament very short and wholly posterior, 10 or 11 slender V-shaped teeth on either side. Length, 7; height, 4; diameter, 2.6 mm., the beaks, 2.5 mm. behind the anterior end. Cat. No. 209396, U.S.N.M.

Station 4325, off La Jolla, California, in 293 fathoms.

TINDARIA DICOFANIA, new species.

Shell small, olivaceous, callistiform, arcuate, with swollen beaks, concentrically uniformly sculptured, nearly equilateral, the anterior end shorter; a small lanceolate lunule and escutcheon present; both ends rounded, base conspicuously arcuate, the posterior end slightly

attenuated; about 11 teeth on each side of the hinge, the ligament wholly external. Length, 4.5; height, 3.2; diameter, 2 mm. Cat. No. 215595, U.S.N.M.

Station 2923, off San Diego, California, in 822 fathoms.

TINDARIA CERVOLA, new species.

Shell small, thin, subtriangular, of a uniform olive color, finely uniformly concentrically sculptured, with a few microscopic radial striulae; base conspicuously arcuate, dorsal slopes nearly straight, the anterior slope shorter, the anterior end rounded, the posterior bluntly pointed, an extremely narrow and small lanceolate lunule and escutcheon present; beaks conspicuous, the prodissoconch visible, whitish; about 10 anterior and 14 posterior teeth, the ligament small, wholly posterior. Length, 4; height, 2.7; diameter, 2 mm. Cat. No. 215594, U.S.N.M.

Station 2923, off San Diego, California, in 822 fathoms.

GLYCYMERIS CORTEZIANA, new species.

Shell solid, white with a brownish periostracum, the surface finely concentrically sculptured, with less conspicuous fine radiating striae, on which the periostracum exhibits ciliated lines; valves moderately compressed, suborbicular, evenly rounded in front and below, somewhat produced behind, the lower margins finely crenulated; beaks small, inconspicuous; area very narrow, closely divaricately grooved; hinge plate broad, with about 12 anterior and 16 posterior teeth. Length, 22; height, 20; diameter, 11 mm. Cat. No. 212431, U.S.N.M.

Station 2918 on the edge of Cortez Bank, California, in 67 fathoms.

GLYCYMERIS MIGUELIANA, new species.

Shell solid, white with sparse zigzag lines of reddish brown and internally often with a touch of brown near the posterior margin; surface smooth except for irregularities of growth; valves suborbicular, anterior side slightly longer, posterior hardly produced; beaks low, area small and divaricately grooved; inner basal margin crenulated; anterior teeth 10-14, posterior 9-12; valves moderately convex. Length, 23; height, 22; diameter, 14 mm. Cat. No. 120775, U.S.N.M.

Station, San Miguel Island, California.

LIMOPSIS SKENIA, new species.

Shell small, finely reticulately sculptured, with a longhaired velvety periostracum; narrow, high, rather inflated, thin, whitish under the brown periostracum; beaks small, area small, hinge line short, with one outer large and one or two small inner teeth on each side of the resilifer. General form oblique. Length, 7; height, 9.2; diameter, 6.5 mm. Cat. No. 205883, U.S.N.M.

Station 4471, Bowers Bank, Bering Sea, in 30 fathoms.

The peculiar narrow oblique form is so far unique in the genus. The margins are smooth.

LIMOPSIS AKUTANICA, new species.

Shell white, with a golden brown long-haired periostracum, the surface concentrically somewhat irregularly sculptured, the ridges crossed by finer, closer, less conspicuous striae; disk ovate, compressed, with inconspicuous beaks, a very small narrow area and a relatively large resilifer; the inner margins are flat; the hinge plate narrow with about 7 posterior and 9 anterior teeth; interior of the disk finely radially striate. Length, 21; height, 18; diameter, 8 mm. Cat. No. 224263, U.S.N.M.

Station 2842, southeast of Akutan Island, Aleutians, in 72 fathoms.

PTERIA VIRIDIZONA, new species.

Shell small, oval, translucent, sea-green, distributed in narrow darker and lighter zones, sculptured with narrow, very elongate, opaque, whitish scales, distributed in radiating lines with wider bare spaces between them; right valve smaller and flatter with a sinus for the byssus; left valve larger with the anterior ear compressed but not sinuate; the hinge line shorter than the shell with a shallow rounded sinus between the posterior ear and the body of the disk; interior with the pearly area small and no denticulations on the hinge line. Length, 25; height, 13; diameter, 5 mm. Cat. No. 172600, U.S.N.M.

Long Beach, California (H. N. Lowe).

VULSELLA PACIFICA, new species.

Shell small, irregular, dark purple margined with white, the surface sculptured with obscure concentric ridges crossed by fine vermiculate radial striations; interior dark purple with white valve margins; resilifer very large and strong, inner valve margins smooth. Length, 9; height, 11; diameter, about 6 mm. Cat. No. 101935, U.S.N.M.

Nicaragua (Thomas Bridges).

The specimen may be young, but it seemed worthy of description, since no species of this genus has hitherto been reported from the Americas.

PSEUDAMUSIUM INCONGRUUM, new species.

Shell small, white, suborbicular, left valve rather flat with short straight hinge line, ears concentrically scaly, sculpture of disk concentric continuous low sharp lamellae, crossed by slightly raised radial lines, conspicuous only at the intersections which form in the

middle of the disk square reticulations with a small conspicuous pustule at each intersection; laterally these are more crowded; right valve concave near the margin, closely regularly concentrically lamellose; anterior ear with five radial lines, coarsely lamellose with a shallow notch and serrate margin. Height, 14; breadth, 15; diameter, 3 mm. Cat. No. 207273, U.S.N.M.

Station 2986, southwest of San Diego, in 684 fathoms.

The sculpture is sparser and partly obsolete near the beaks.

PSEUDAMUSIUM BISTRIATUM, new species.

Shell small, suborbicular, moderately convex, white, thin; left valve finely concentrically, rather distantly lamellose, the lamellae closer and more conspicuous on the subequal ears; radial sculpture of very fine, close-set, uniform almost microscopic elevated lines, which do not reticulate the lamellations; right valve with the concentric, but without the radial sculpture, concave near the margin, the disk about as convex as the other valve, ears subequal, byssal notch short, acute; one or two faint radii on the ear above it. Height, 7; breadth, 7; diameter, 2 mm. Cat. No. 214056, U.S.N.M.

Station 2923, off San Diego, California, in 822 fathoms.

LIMATULA ATTENUATA, new species.

Shell small, narrow, thin, white, radially sculptured with low, rather close-set, rounded threads, crossed near the distal margin with low concentric irregular lamellations so as to give that part of the valve a minutely scabrous effect; the medial radii are broader than the others and radially striate, no mesial sulcus is noticeable but it is clearly indicated on the inside of the valve; beaks low, incurved; area triangular, resilifer large and excavated; hinge margin short, strongly buttressed on each side; valve margin crenulate. Height, 7; width, 3.6; diameter, 4 mm. Cat. No. 220510, U.S.N.M.

Nazan Bay, Atka Island, Aleutian chain.

SEPTIFER BIFURCATUS, new variety, *OBSOLETUS*.

Shell large, the external sculpture obsolete, the distal part of the valves nearly smooth. Cat. No. 173359, U.S.N.M.

San Diego Bay, mud flats.

MODIOLUS (?*POLITUS* Verrill var.) *PALLIDULUS*, new species.

Shell thin, smooth, brilliantly polished, attenuated anteriorly, wide and bluntly rounded behind, divided into two color areas, the dorsal large, translucent with a whitish zigzag reticulation, the ventral opaque white with a yellowish tinge; hinge edentulous, margins entire. Length, 23; maximum height, 11.5; beaks behind the anterior end, 1; diameter, 5 mm. Cat. No. 212746, U.S.N.M.

Station 3197, off San Luis Obispo Bay, in 77 fathoms.

None of the Pacific specimens have the golden yellow color of the Atlantic species and none of them attain the same size. Otherwise the shells are very similar.

DACRYDIUM PACIFICUM, new species.

Shell minute, whitish, much the shape of *Musculus vernicosus* Middendorff, on a minute scale, differing from the Atlantic *D. vitreum* by its smaller size and more elongated outline. Length, 3.6; height, 2.5; diameter, 1.5 mm. Cat. No. 214092, U.S.N.M.

Station 3604, 1,401 fathoms, mud, in Bering Sea.

MUSCULUS NIGER Gray, new variety, OBESUS.

Shell resembling the typical flattish form but markedly more inflated. Length, 60; height, 31; diameter, 18 mm. Cat. No. 223317, U.S.N.M.

Plover Bay near Bering Strait, in 8 to 20 fathoms.

MUSCULUS NIGER Gray, new variety, PROTRACTUS.

Shell resembling the young of the typical form but more inflated and elongated, the sculpture very distinct, the medial area smooth, blackish, the dorsal areas olivaceous. Length, 13; height, 6.5; diameter, 5.5 mm. Cat. No. 222017, U.S.N.M.

North of Nunivak Island, Bering Sea, in 9 fathoms, gravel.

MUSCULUS OLIVACEUS, new species.

Shell small, thin, polished, pale olivaceous near the beaks, growing darker distally; medial area smooth, anterior area with six or seven rather strong radial grooves; posterior area with numerous shallow channeled radii crossed by rather regular slightly elevated concentric lines, giving a silky luster to the surface; beaks inconspicuous, inflated; dorsum arched, base nearly straight, both ends evenly rounded, the posterior slightly wider; interior whitish, the margin crenulated by the sculpture, the beaks very close to the posterior end. Length, 10; height, 6; diameter, 5 mm. Cat. No. 210790, U.S.N.M.

Off Bering Island, in 10 fathoms.

This differs in sculpture, color, and proportions from the young of *M. laevigatus*.

Genus LITHOPHAGA Bolten, 1798.

Section LABIS Dall, 1916.

Type.—*Lithophaga attenuata* Deshayes.

The typical *Lithophaga* has a clean outer surface; *Diberus* a divaricate plumose posterior incrustation; *Myoforceps*, two crossed conical projections; the present form has on each valve a semicylindrical

smooth appendage of which the distal end is internally flattened and somewhat separated from the appendage of the opposite valve, the ends being rounded.

CRENELLA ROTUNDATA, new species.

Shell small, rounded-quadrate, inflated, with a very thin, dehiscent, pale olive periostracum; beaks central, inconspicuous, with no crenulations beneath them; sculpture of faint incremental lines and obsolete radial striae near the margin; inner margin very delicately crenulate except near the beaks. Length, 4; breadth, 4; diameter, 2 mm. Cat. No. 129305, U.S.N.M.

Station 2849, off Santa Cruz Island, California, in 155 fathoms, sand.

DERMATOMYA BUTTONI, new species.

Shell small, rounded-quadrate, plump, thin, yellowish olive, hardly polished, smooth, with iridescent reflections from under the periostracum when fresh; beaks nearly central, not prominent, hinge teeth normal, strong; interior bluish white, margins entire, pallial sinus shallow. Length, 9.8; breadth, 8; diameter, 6 mm. Cat. No. 194309, U.S.N.M.

Station 3670, Monterey Bay, in 581 fathoms.

DERMATOMYA BERINGIANA, new species.

Shell large, thin, plump, inequilateral, anterior end shorter, base arcuate, anterior end rounded, posterior dorsal slope first convexly slightly arcuate, then obliquely subtruncate to meet the basal curve; beaks prominent, 7 mm. behind the anterior end; surface smooth, except for faint incremental irregularities, iridescent under a pale olive, polished periostracum; beaks slightly prosocoelous, hinge weak, the teeth minute, the ossiculum well developed; interior whitish, the pallial sinus very shallow. Length, 20; height, 14; diameter, 12 mm. Cat. No. 205899, U.S.N.M.

Bowers Bank, Bering Sea, in 557 fathoms.

DERMATOMYA LEONINA, new species.

Shell large for the genus, mactriform, solid, inflated, transverse, with a dull olivaceous periostracum, darker, and concentrically wrinkled on the posterior dorsal area; surface smooth except for fine incremental lines and microscopic radial striulae often obsolete; beaks high, slightly prosocoelous, nearly central; base moderately arcuate, anterior end rounded, dorsal slopes nearly straight, a shallow radial depression on the posterior dorsal area, posterior end subtruncate; hinge weak, ligament deeply inset; hinge teeth almost obsolete; margins entire, pallial sinus shallow, interior feebly iridescent

white. Length, 27; height, 18.5; diameter, 14.6 mm. Cat. No. 122564, U.S.N.M.

Station 3074, off Sea Lion Rock, coast of Washington, in 877 fathoms.

CETOCONCHA MALESPINAE, new species.

Shell small, very thin, with prominent prosocoelous beaks, a very pale yellowish olive periostracum, darker on the posterior dorsal area; in the right valve is a strong radial ridge near the posterior hinge line; surface otherwise smooth and almost polished except for extremely fine radial lines of minute granules only visible under a glass; shell very similar to *Isocardia cor* in form and outline on a very small scale; interior white, the hinge normal but weak. Length, 12.5; height, 10; diameter, 8.5 mm. Cat. No. 212564, U.S.N.M.

Station 2859, southwest of Sitka Bay, Alaska, in 1,569 fathoms.

MYONERA TILLAMOOKENSIS, new species.

Shell extremely thin, fragile, inflated, beaks nearly central (neglecting the rostrum), whitish, the anterior part of the shell with about 20 strong, rounded, concentric ripples which cease posteriorly at the anterior border of the radial sculpture which includes four strong and about fifteen threadlike radial riblets extending from the beaks to the base, behind which is a short, blunt, concentrically feebly striate, truncate rostrum; base arcuate, hinge-line nearly straight, the right margin slightly overlapping the other. Length, 18; height, 12; diameter, 10 mm. Cat. No. 107819, U.S.N.M.

Station 3346, off Tillamook Bay, Oregon, in 786 fathoms.

CUSPIDARIA APODEMA, new species.

Shell small, white, polished, swollen, with a prominent tubular rostrum; inequilateral, the beaks 6 mm. behind the anterior end; the rostrum about 5 mm. long; beaks conspicuous, prosocoelous; the exterior smooth except for incremental lines and wrinkles on the dorsal side of the rostrum; hinge-line nearly straight, anterior end rounding imperceptibly into the semicircular base which is suddenly constricted at the rostrum. Length, 17; height, 10; diameter, 8 mm. Cat. No. 122602, U.S.N.M.

Station 2859, southwest of Sitka Bay, Alaska, in 1,569 fathoms. Near but not *C. obesa* Lovén, of the Atlantic.

CARDIOMYA BALBOAE, new species.

Shell small, whitish with a yellowish periostracum; inequilateral, rostrate, somewhat inflated, posterior end shorter, anterior ovately rounded; beaks small, pointed, not elevated; sculpture of anterior half of the disk faintly irregularly concentrically rippled; behind this 12 to 15 radial, more or less alternated threads extending to the

margin from the umbones and increasing in strength backward; behind the last and strongest an excavated concentrically striated space marks the beginning of the rostrum which beyond that has four or five faint radial threads and is abruptly truncate. Length 8.9; height, 5; diameter, 3.2 mm. Cat. No. 208650, U.S.N.M.

Station 2911, on the edge of Cortez Bank, in 60 fathoms.

CALYPTOGENA ELONGATA, new species.

Shell resembling a *Tagelus* in form, elongate compressed, white under a yellowish periostracum, rounded at both ends, base nearly straight; anterior dorsal slope short, beaks low, small, pointed, about 10 mm. from the anterior end of the valves, posterior slope long, gently arcuate; surface devoid of any sculpture except rather conspicuous incremental lines; ligament strong; interior porcellaneous white, pallial line entire; hinge teeth small, normal. Length, 44; height, 17.5; diameter, 10 mm. Cat. No. 110774, U.S.N.M.

Off Point Loma, California, in 275 fathoms, at station 4432.

This can be distinguished at once from the *C. pacifica* by its elongate form and more delicate and compressed shell.

MIODONTISCUS MERIDIONALIS, new species.

Shell small, solid, white, with 9 or 10 strong rounded adjacent radial ribs cut by about as many concentric incised lines, the segments of the ribs more or less swollen; beaks small, erect, no visible lunule, or escutcheon; teeth strong; inner basal margin coarsely crenulate. Length, 4; height, 4; diameter, 2 mm. Cat. No. 208948, U.S.N.M.

Station 4309, off Point Loma, California, in 78 fathoms.

Smaller, less compressed, and more conspicuously sculptured than the northern *M. prolongatus*.

MILNERIA KELSEYI, new species.

This species has been confused from the beginning with *M. minima* Dall, and is best diagnosed comparatively. The latter has the radial sculpture, especially the four strong ribs of the posterior part, coarsely and conspicuously imbricated, with no very marked keel from the umbo to the posterior basal angle. The shell in a general way is in all respects less angular. *M. kelseyi* has a conspicuous ridge extending from the umbo to the posterior basal angle; the imbricated ribs are less conspicuous, the scales smaller and less prominent, the anterior end more attenuated, the shell wider and more depressed, and is apparently larger when mature. Length, 11; height, 3; diameter, 4.5 mm. Cat. No. 253037, U.S.N.M.

On *Halotis* shells, Central California.

M. minima has a rather large conspicuous impressed lunule and smaller narrow escutcheon; *M. kelseyi* an extremely small lunule and an escutcheon larger and more conspicuous.

THYASIRA CYGNUS, new species.

Shell white with a pale straw-colored periostracum, moderately convex, sharply compressed behind, the beaks prominent, prosocoealous over a large cordate lunule, the escutcheon long and very narrow, bounded by a sharp keel; general form rounded quadrate, the compressed posterior area narrow and basally falling notably short of the basal curve of the disk; posterior slope slightly convexly arcuate; anterior distinctly concave, meeting the basal arc in an obtuse angulation. Length, 14; height, 13.5; diameter, 8.5 mm. Cat. No. 222618, U.S.N.M.

Station 4224, Cygnet Inlet, Boca de Quadra, Alaska, in 160 fathoms.

THYASIRA TRICARINATA, new species.

Shell chalky white, produced below, with pointed prosocoealous beaks over a deeply impressed ovate lunule bounded by a sharp carina; escutcheon long, narrow, lanceolate, the valve margins rising as a sharp keel in the middle, the outer border very prominently keeled, outside of which is a similarly shaped excavated area also bordered by an angular keel; still outside of this there is a compressed area with no distinct anterior boundary except an obscure ray near the umbones; over this area the surface is concentrically striated, the rest of the disk being nearly smooth; hinge very feeble, ligament linear. Length, 15; height, 18; diameter, 10 mm. Cat. No. 209321, U.S.N.M.

Station 4425, off the Santa Barbara Islands, California, in 1,100 fathoms.

ERYCINA CATALINAE, new species.

Shell small, inequilateral, the anterior side shorter, rounded, the base nearly straight; posterior side also rounded, slightly attenuated, the dorsal slope convex but descending; hinge strong, the teeth well developed; the beaks well developed, not prominent, the surface smooth except for faint incremental lines, covered with a light yellowish-brown dull periostracum. Length, 2.5; height, 2; diameter, 1.3 mm. Cat. No. 210879, U. S. N. M.

Catalina Island. California, Brannan.

ERYCINA? CORONATA, new species.

Shell small, white, rounded quadrate, nearly equilateral, the surface finely concentrically striated; basal margin nearly straight; ends rounded, the posterior a little produced basally, the dorsal slopes similar, slightly descending, with at each end two to four minute elevated spinules. Length, 4; height, 3; diameter, 1.2 mm. Cat. No. 225193, U.S.N.M.

Off South Coronado Island, in 3 to 6 fathoms, Dr. F. Baker. Only one left valve was obtained.

ERYCINA BAKERI, new species.

Shell small, white with a pale yellowish periostracum, subquadrate, inequilateral, the anterior end shorter; hinge line short, straight, at the outer extremities usually a small spinule, beaks pointed, the prodissoconch visible; from the beak extends a wide depression obliquely backward to the middle of the base, becoming more defined distally; at the base in the adult it is strongly marked and emphasized by a rounded sulcus in the margin, behind which the surface rises into a rounded ridge armed with one or more elevated short lamellae, and having its basal termination produced into a sort of hook; hinge rather feeble, valves rather compressed. Length, 6.3; height, 4.5; diameter, 2 mm. Cat. No. 225192, U.S.N.M.

Off South Coronado Island, in 3 to 6 fathoms, Dr. F. Baker.

This remarkable little shell doubtless owes its curious modifications to a commensal habit of living attached to some other animal—a crustacean or annelid.

ERYCINA BALLIANA, new species.

Shell small, with the outline of a very compressed *Kellia*, white with a very pale yellowish periostracum, concentrically microscopically threaded, the threads occasionally becoming microscopically lamellar; valves nearly equilateral, the anterior part slightly longer, base evenly arcuate, the posterior end somewhat attenuated. Length, 3; height 2.9; diameter, 1.7 mm. Cat. No. 225191, U.S.N.M.

Off South Coronado Island in 3 fathoms, Dr. F. Baker. Named in honor of Mrs. Paula Ball, of the Conchological Club of Los Angeles, California.

ERYCINA CHACEI, new species.

Shell small, compressed, rounded-quadrate; nearly equilateral, the anterior end slightly shorter; beaks low, pustular, minute; dorsal margin nearly straight, basal margin gently arcuate; surface finely concentrically striate, whitish under a pale ashy periostracum, both ends nearly evenly rounded, hinge very feeble. Length, 5.3; height, 3.5; diameter, 1.8 mm. Cat. No. 211219, U.S.N.M.

Station 4343, off the South Coronado Island, in 155 fathoms. This shell may eventually prove to be a *Pseudopythina*. Only one right valve was obtained. It is named in honor of Mr. and Mrs. E. P. Chace, of Los Angeles, California.

ERYCINA SANTAROSAE, new species.

Shell small, compressed, whitish, with a thin pale brownish dull periostracum; profile approaching *E. balliana* but more elongated, and the surface smooth, almost polished and without the microscopic concentric sculpture; evenly ovate, nearly equilateral, the anterior end a

trifle shorter; beaks low, pustular, the prodissoconch very small but distinct. Length, 4; height, 3.5; diameter, 1.5 mm. Cat. No. 194339, U.S.N.M.

Santa Rosa Island, California.

ANISODONTA? PELLUCIDA, new species.

Shell minute, white, pellucid, rounded triangular, smooth and polished; beaks prominent, dorsal slopes convexly arcuate behind, straighter in front; base arcuate, valves moderately arcuate with entire margins; hinge with developed anterior and posterior laterals and two cardinals, the anterior tooth bifid. Length, 2.3; height, 2; diameter, 1.3 mm. Cat. No. 208475, U.S.N.M.

Monterey Bay, California.

The generic place of this minute shell is doubtful, but the form is distinctly like *Eucharis*, though the hinge appears to differ.

ROCHEFORTIA FERRUGINOSA, new species.

Shell small, white, thin, subdonaciform, compressed, invariably coated with a ferruginous layer like some species of *Axinulus*, inequilateral; anterior side longer, apical angle about 90; both ends rounded base arcuate. Length, 4.5; height, 3.25; diameter, 1.5 mm. Cat. No. 214413, U.S.N.M.

San Francisco Bay.

ROCHEFORTIA BERINGENSIS, new species.

Shell large for the genus, oval, white with an olivaceous periostracum, thin, somewhat compressed, sculptured rudely with low irregular concentric ridges; inequilateral, posterior end longer, both rounded; beaks not prominent, hinge small and feeble, except that the resilium and its attachments are rather large. Length, 11.5; height, 10; diameter, 4 mm. Cat. No. 210951, U.S.N.M.

Bering Island, Bering Sea (Grebnitzsky).

ROCHEFORTIA GREENITZSKII, new species.

Shell small, translucent, polished, whitish; nearly equilateral; general shape that of *Bornia*, but without the brilliant surface; sculpture of fine concentric lines visible under a glass, which render the surface dull; beaks rather prominent, hinge weak. Length, 3.25; height, 2.5; diameter, 1.3 mm. Cat. No. 207258 a, U.S.N.M.

Bering Island, Bering Sea (Grebnitzsky).

This may ultimately prove to be a *Bornia*.

ROCHEFORTIA GOLISCHI, new species.

Shell subquadrate, compressed, thin, white, very inequilateral; the anterior end very short, beaks low, 1 mm. behind the anterior

end; posterior end rounded almost exactly like the anterior, base gently arcuate; surface polished, minutely concentrically rippled; prodissoconch visible; hinge weak, the resilifer large, obliquely inclined backward. Length, 6; height, 5.5; diameter, 2.5 mm. Cat. No. 210876, U.S.N.M.

Station 2900, off Santa Rosa Island, California, in 13 fathoms. Named in honor of Mr. W. H. Golisch, of the Los Angeles Conchological Club.

PSEUDOPYTHINA MYACIFORMIS, new species.

Shell small, myaciform, plump, nearly equilateral, the posterior end slightly shorter, wider, and rounded; anterior end more attenuated; surface finely concentrically threaded, but obscured by an habitual coating of a blackish color, probably manganese dioxide; the shell underneath it is yellowish white; hinge weak, the ligament carrying a long, very narrow, lithodesma. Length, 8.5; height, 5.5; diameter, 3 mm. Cat. No. 133235, U.S.N.M.

Port Orchard, Puget Sound. The young shells are proportionately shorter.

TRIGONICARDIA EUDOXIA, new species.

Shell small, mottled with lighter and darker rose-color, suborbicular, inflated, strongly sculptured; radial sculpture of 15 sharp angular ribs with subequal interspaces, the keel of the ribs sparsely, regularly, minutely pustular; on the posterior dorsal area are six additional smaller more closely pustular riblets; the interspaces in all are finely concentrically rugose; the hinge is strong; the interior margins deeply sulcate in harmony with the radial sculpture; the central part of the interior is whitish. Length, 9; height, 9; diameter, 8 mm. Cat. No. 208590, U.S.N.M.

Station 3020, Gulf of California, in 7 fathoms.

PROTocardia PAZIANA, new species.

Shell small and delicate, resembling *P. panamensis* Dall, but smaller, more delicate, more elongated, and with the spinose posterior sculpture much more prominent when preserved intact; sculpture of about 40 anterior minutely nodulous ribs, each giving the effect of a string of beads, and to the interspaces of punctation; there are about 22 ribs on the posterior area, which, when intact, carry close-set spinules; the inner margins are sharply serrate; the hinge margin near the umbones has a tinge of crimson, otherwise the shell is yellowish white. Length, 10; height, 8.6; diameter, 6 mm. Cat. No. 211618, U.S.N.M.

Station 2828, off La Paz, Gulf of California, in 10 fathoms.

CARDIUM DULCINEA, new species.

Shell obliquely ovate, strongly radially sculptured with about 22 rounded ribs with narrower not channeled interspaces; the more

anterior ribs are flattened; between the last six in the narrow interspaces is a minute undulation which becomes obsolete as the shell grows; the color of the shell is ivory white, more or less concentrically mottled with reddish brown; interior white, channeled in harmony with the radial sculpture, the margins, especially behind, deeply sulcate; beaks prominent, conspicuously incurved. Length, 43; height, 52; diameter, 36 mm. Cat. No. 193824, U.S.N.M.

Real Llejos, Gulf of Dulce, Central America.

SAXIDOMUS GIGANTEUS DeKayes, 1839.

New variety *brevis*. Shell short, subtriangular, small in comparison with type and much less elongated. Length, 60; height, 50; diameter, 33 mm. Cat. No. 204020, U.S.N.M.

Mole Harbor, Admiralty Islands, Alaska, Mrs. Stephens.

PROTOTHACA STAMINEA, new variety *SPATIOSA*.

Shell large, heavy, rounded quadrate, inequilateral, the beak behind the anterior end 18 mm.; yellowish or brownish white without markings; sculpture of simple, similar, narrow radial ribs with narrower interspaces, except on the posterior dorsal area where there are a few wider ribs with deeper interspaces; inner margins finely crenulate; pallial sinus deep, narrow, nearly horizontal. Length, 80; height, 67; diameter, 50 mm. Cat. No. 151562, U.S.N.M.

Coos Bay, Oregon, Dall.

PSEPHIDIA BRUNNEA, new species.

Shell small, rounded triangular, moderately convex, brown, pale yellow with zigzag brown reticulation, or even pale yellowish with only traces of red or brown on the hingeline; surface apparently smooth, with a dull silky effect, which on magnification is seen to be due to minute concentric close-set threadlike sculpture; beaks prominent, prodissoconch minute but distinct; hinge normal, strong; inner margins entire, pallial sinus shallow, irregular. Length, 3.7; height, 3; diameter, 2 mm. Cat. No. 109469, U.S.N.M.

Catalina Island, California, in 16 fathoms, Dall.

The shells are often crowded with nepionic young as in *Sphaerium*.

MACOMA BROTA, new name.

This is *Tellina edentula* Broderip and Sowerby, 1829, not of Spengler, 1793; and in part *T. lata* of Middendorff, 1851, not of Gmelin, 1792.

The following form would seem to be specifically distinct were there not a few intermediate specimens:

MACOMA BROTA, new variety, LIPARA.

Shell resembling *brota* but more rotund, less rostrate, with a wider and rounder anterior end, shorter and more rounded posterior end, and more polished surface. The respective measurements are as follows, in millimeters: 219,461; *M. brota*: Height, 53; length, 74; diameter, 22; posterior end, 32. 223,032; *M. lipara*: Height, 57; length, 74; diameter, 25; posterior end, 33. Cat. No. 223032, U.S.N.M.

Both have the same distribution south of Bering Strait, but I have not seen *lipara* from Arctic waters. Both reach Puget Sound.

MACOMA INQUINATA DeKayes, 1854.

New variety *arnheimi*. Shell resembling the typical *inquinata* but shorter, and relatively more plump; the beaks 15 mm. behind the anterior end; the basal margin somewhat produced; the rostration shorter, less pronounced and less obliquely twisted. Length, 38; height, 30; diameter, 15 mm. Cat. No. 122537, U.S.N.M.

Kodiak Island, Alaska, Arnheim.

MACOMA QUADRANA, new species.

Shell small, white, polished, intermediate between *M. carlottensis* Whiteaves, and *M. inflatula* Dall, but smaller than either; periostracum pale straw color, slightly iridescent, microscopically concentrically striated; anterior end larger, posterior end short, obliquely subtruncate, the rostrum slightly bent to the right; the right valve a little flatter than the left; two faint low riblets extending from the beaks to the posterior basal angle; hinge very weak, pallial sinus deep and high. Length, 19; height, 13.5; diameter, 7 mm. Cat. No. 225421, U.S.N.M.

Boca de Quadra, Alaska. Type-specimens from off Point Conception at station 2892, in 284 fathoms

MACOMA TRUNCARIA, new species.

Shell small, subquadrate, white, nearly equilateral, the posterior end slightly shorter, attenuated subtruncate; basal margin nearly straight, anterior end evenly rounded, beaks not prominent, dorsal slopes subequal, the posterior steepest; sculpture only of incremental lines irregularly prominent; hinge teeth feeble; interior chalky white, the pallial sinus reaching only to the vertical of the beak, rounded, free from the pallial line. Length, 15; height, 10; diameter, 4 mm. Cat. No. 210916, U.S.N.M.

Arctic coast between Cape Halkett and Garry River.

ERVILIA CALIFORNICA, new species.

Shell small, ovate, white with a rosy flush, inequilateral, the posterior end shorter; the beaks inconspicuous, the ends rounded, the

basal margin arcuate; sculpture of fine close-set regular, uniform concentric threads over the whole surface; hinge strong, pallial sinus small. Length, 7; height, 4.5; diameter, 2 mm. Cat. No. 151419, U.S.N.M.

San Pedro, California, Bridwell.

MACTRELLA CLISIA, Dall, 1915.

Shell large, white, with a thin, dehiscent periostracum, conspicuously arcuate, inflated, and egregiously keeled around the posterior dorsal slope; anterior end produced, attenuated, rounded; beaks very high, notably prosocoelous; posterior slope sharp, posterior end flattened, the flat area bordered with a high keel, in front of which is a marked constriction; the flat area is divided by an elevated ray into two nearly equal parts which are somewhat excavated; the valve margins near the beaks prominently produced; sculpture only of lines of growth which are fairly conspicuous; hinge line extremely short, pallial sinus reaching only to the vertical from the posterior lateral teeth, the posterior end with an oval gape. Length, 88; height, 66; diameter, 32 mm. Cat. No. 271481, U.S.N.M.

Type from Manzanillo, Mexico. Range thence to Santa Elena, Ecuador.

This remarkable shell is more like the West Indian species than it is to *M. exoleta* of the Pacific coast, but all its characters are, as it were, exaggerated to a fantastic extent.

SPHENIA TRUNCULUS, new species.

Shell short, whitish with a dirty ash-colored periostracum, rude and more or less distorted, abruptly truncate, almost equilateral, the anterior portion swollen, the posterior part attenuated. Length, 7; height, 4.3; diameter, 4 mm. Cat. No. 160116, U.S.N.M.

San Diego, California, among barnacles on the wharf piles.

SPHENIA PHOLADIDEA, new species.

Shell small, thin, white, with a blackish periostracum, which is conspicuously laminate on the posterior dorsal area; very inequilateral, the anterior side shorter, the beaks inconspicuous, 4 mm. behind the anterior end; sculpture of rude incremental lines, posterior end abruptly truncate, hardly attenuated; pallial sinus rounded, not reaching the vertical of the beaks; hinge with a prominent toothlike projection in the right valve before, in the left valve behind the resiliifer. Length, 12; height, 5.3; diameter, 4 mm. Cat. No. 2581, U.S.N.M.

Santa Barbara, California, Major Rich.

CORBULA PORCELLA, new species.

Shell small, ashy white, inequivalve, the left valve smaller; inequilateral, the posterior end larger; rounded in front, pointed behind;

a prominent angle separates the posterior dorsal area from the rest of the disk; surface concentrically evenly threaded, the threads a little more pronounced on the dorsal area; an obscure almost microscopic radial striation is sometimes apparent; the siphons protrude beyond the rostrum with a dense covering of wrinkled periostracum; interior white, hinge normal, the basal margin of the right valve partly overlapping that of the left valve; pallial sinus obsolete. Length, 8.5; height, 4; diameter 4.5 mm., but the shell is often larger. Cat. No. 97039, U.S.N.M.

Station 2838, off Lower California, in 44 fathoms, mud. The species extends northward to the Santa Barbara Islands, California.

CORBULA KELSEYI, new species.

Shell rather large, rounded triangular, whitish, heavy, not inflated; the surface sculptured by low concentric lamellae, a little more prominent near the posterior end of the shell, separated by equal or slightly wider interspaces crossed by fine radial threads which do not crenulate the lamellae; there is no defined posterior dorsal area or keel; interior with a deep anteriorly rounded pallial sinus, fused with the pallial line below for the greater part of its length. There seems to be a small narrow lunular area in the left valve. Length, 16; height, 10; diameter of left valve, 3 mm. Cat. No. 120691, U.S.N.M.

Catalina Island, California.

Named in honor of Prof. F. W. Kelsey of San Diego.

PANOMYA ARCTICA Lamarck, new variety, **TURGIDA**.

Shell very similar to the North Atlantic form but very much more capacious and larger. Length, 90; height, 60; diameter, 48 mm. Cat. No. 151224, U.S.N.M.

This form is common to the Aleutian Islands, and eastward as far as the Shumagins. The type-specimen is from Popoff Strait in the Shumagin group, Alaska.

PANOMYA BERINGIANA, new species.

Shell resembling *P. arctica* Lamarck, in a general way, but thinner, less cylindrical, much larger, and proportionately shorter. Length, 130; height, 80; diameter, 50 mm. A single valve reaches a length of 150 and a height of 110 mm. Type-specimen, Cat. No. 212875. U.S.N.M.

Station 3529, near the Pribiloff Islands, in 56 fathoms. Eastern Bering Sea in general.

SAXICAVELLA PACIFICA, new species.

Shell small, thin, white, with a pale olive dehiscent periostracum; inequilateral, the anterior end shorter and more attenuated, the posterior longer, more vertically expanded; surface sculptured only by

incremental lines; a rounded ridge extends from the inconspicuous beak to the posterior basal margin, but there is no keel or angle; interior distinctly pearly, hinge as in the Atlantic species. Length, 5.8; height, 3; diameter, 2 mm. Cat. No. 209912, U.S.N.M.

Station 4356, 131 fathoms, off Point Loma, San Diego County, California.

PHOLADIDEA SAGITTA (Stearns Ma.).

Shell closely similar to *P. penita* Conrad, but with shorter proportions, measured longitudinally, and with a corresponding widening of the dorsal appendages of the adult. In all other respects it resembles *P. penita*, of which it is doubtless a variety. The name having found its way into collections, it was thought best to give it an acknowledged status. The type-specimen comes from Monterey, California. Cat. No. 63312, U.S.N.M.

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A NEW FIND OF METEORIC STONES NEAR PLAINVIEW, HALE COUNTY, TEXAS.

By GEORGE P. MERRILL.

Head Curator, Department of Geology, United States National Museum.

The stones described below were forwarded to the Museum by Mr. Harl Rightmire, who reports that they were found some 5 miles southwest of Plainview, in Hale County, Texas. Nothing is known regarding the fall, and as the various individuals show unmistakable evidences of having lain a long time in the soil, speculation is useless.

Three fairly complete individuals and a fragment were forwarded, weighing respectively 870 (fragment), 1320, 1,915, and 3,450 grams. Small fragments broken from two of the individuals are estimated to have weighed about 50 grams, bringing the total weight up to 7,605 grams. Inasmuch as the largest individual is plainly a spawl from a still larger mass, such figures are of little value excepting to the dealer and collector. Two of the more complete individuals, the first and third in size, are shown on plate 34, the larger being about 17 by 16½ by 7½ cm. in diameter. All are well encrusted, though discolored by oxidation. (See Addendum, p. 421.)

The fact that the pieces are obviously fragments from a large mass, and that Hale County abuts directly on Crosby County, led at first to the prompt suggestion that they might have belonged to the Estacado fall. A single glance at a thin section is enough, however, to show this to be incorrect, as the stones are of quite different types.

The smaller of the Plainview stones are too much oxidized to render exterior markings of much value, but apparently the face of the largest mass shown in figure 2 was the *brustseite*, as distinct radiations may be seen extending outward in all directions from the thumb pittings shown in the upper center (see pl. 34).

In thin section this meteorite is found to be of a common chondritic type, consisting of chondrules and fragments of chondrules in a finer ground in part crystalline and in part fragmental of the same mate-

rial interspersed with the usual metallic iron and abundant iron sulphide. The silicate minerals are olivine and pyroxenes of both the normal orthorhombic and twinned monoclinic types. No feldspars are present. Oxidation has badly obscured the finer details of structure and rendered impossible the identification of any minor constituents which might perhaps exist. The pulverized material boiled in water for half an hour gave a filtrate reacting distinctly for chlorine, calcium, and sulphur, and a portion allowed to stand for a like length of time in one part nitric acid and 20 parts water, gave strong qualitative reactions for P_2O_5 , CaO , and Fe_2O_3 . A complete analysis by Dr. J. E. Whitfield yielded:

	Percent.
Metal.....	6.22
Metallic sulphide.....	9.57
Silicates.....	84.21
Total.....	100.00

The metallic portion yielded:

Iron.....	90.63
Nickel.....	8.85
Cobalt.....	.38
Phosphorus.....	.14
Total.....	100.00

The silicate portion yielded:

Silica (SiO_2).....	41.45
Ferric oxide (Fe_2O_3).....	3.46
Chromic oxide (Cr_2O_3).....	.40
Alumina (Al_2O_3).....	3.17
Ferrous oxide (FeO).....	17.77
Manganous oxide (MnO).....	.21
Lime (CaO).....	1.68
Magnesia (MgO).....	28.99
Nickel oxide (NiO).....	.91
Cobalt oxide (CoO).....	.04
Soda (Na_2O).....	.90
Potash (K_2O).....	.14
Total.....	99.12

A recalculation of these results gives the mass composition of the stone as follows:

Metallic portion:

Iron (Fe).....	5.64
Nickel (Ni).....	.55
Cobalt (Co).....	.02
Phosphorus (P).....	.01

Troilite:

Iron (Fe).....	6.09
Sulphur (S).....	3.48

Silicates:

Silica (SiO_2).....	35.31
Ferric oxide (Fe_2O_3).....	2.95
Chromic oxide (Cr_2O_3).....	.34
Alumina (Al_2O_3).....	2.70
Ferrous oxide (FeO).....	15.13
Manganous oxide (MnO).....	.18
Lime (CaO).....	1.43
Magnesia (MgO).....	24.69
Nickel oxide (NiO).....	.77
Cobalt oxide (CoO).....	.003
Soda (Na_2O).....	.76
Potash (K_2O).....	.12
Chlorine (Cl).....	not det.
Total.....	100.173

The phosphorus, although determined in the soluble metallic portions, is in part present as a phosphate, as already noted, the chromium is present as chromite, while the troilite is calculated from the 3.48 per cent of sulphur found.

The texture of the stone is firm and the chondrules in large part break with the matrix. The ground in the fresh, unoxidized portion is crystalline, though in places doubtfully fragmental. I have classed it provisionally as a spherical chondrite (Cc). It will be known as the Plainview meteorite. The second largest mass, weighing 1,915 grams, is in the collections of the Field Museum of Natural History, Chicago. (See Addendum below.)

EXPLANATION OF PLATES.

PLATE 34.

The Plainview, Texas, meteorites. Cat. No. 521.

FIG. 1. The 1,320-gram stone as received.

2. The largest single individual of the Plainview meteorites, weighing 3,450 grams. The view shows the *brustseite* with radiations extending outward in all directions from the large thumb markings in the upper central portion of the figure.

PLATE 35.

Plainview meteorites, second find.

No. 1, 863 grams; No. 2, 2,527 grams; No. 3, 2,940 grams; No. 4, 4,592 grams; and No. 5, 5,585 grams.

ADDENDUM.

Since the above was written five more stones have been received, which Mr. Rightmire reports as having been found 2 miles west of those first discovered. These, as shown on plate 35, weigh, respectively, 863, 2,527, 2,940, 4,592, and 5,585 grams. Of these, No. 4 is of principal interest, showing areas of primary incrustation only at a few points, as at the lower extremity of the figure. The remaining surfaces show secondary incrustations over more recent fractures. Numbers 2, 3, and 5 are fairly complete individuals, though showing also secondary crusts over limited areas. Thin sections prepared from several individuals were at first thought to present structural

details such as to warrant referring them to a separate fall, but further study has led to the belief that the stone is a breccia, though the structural variations may be in part due to weathering.

When the possibility of brecciation was realized, the smallest (870-gram) fragment of the first find was cut in halves and polished. The resultant surfaces showed a ground of about equal parts light gray, mainly oxidized to reddish, and darker gray more or less angular areas. Both portions are equally injected with small, but abundant points of metallic iron and iron sulphide. There are also occasional light-gray fragments, some 2 to 4 mm. in length, which are evidently pyroxenic. To the unaided eye both portions are chondritic, though this structure is much more pronounced in the dark areas. It was at first thought that this difference might be merely apparent and due to the obscuring of the structure in the lighter portions through oxidation. Further investigation has, however, shown that this conclusion will not hold. Under the microscope the lighter portion is chondritic and consists wholly of olivine and enstatite with the metallic iron and iron sulphide. None of the twin pyroxenes so characteristic of the dark portion, which was the material described in the first part of this paper, are present. Further than that, the chondrules in the light portion are almost wholly very light gray and nearly white, while those in the dark portions are in part of a dark-gray color, although there are white chondrules here also. By reflected light the polished surface shows a structure distinctly brecciated, and in one or two cases it is possible to trace the outlines of a fragment of the darker rock inclosed in the lighter gray, but in the majority of cases this is impossible, and the darker material is so commingled with the lighter that for a long time considerable uncertainty existed in the mind of the writer as to the true nature of the stone. Even now he confesses to not feeling fully satisfied, but until one of the larger masses of the new find can pass into the possession of the Museum and be sawn through the center, in the hopes of getting beyond the zone of oxidation, this is the best that can be done. The strongest argument in favor of the brecciated nature of the stone seems to lie in the presence of the polysynthetically twinned pyroxenes in the dark-gray chondrules and their absence in the lighter portions. In one instance the line of demarkation between the light and dark portions could be plainly traced in thin section, and the metallic sulphides were found elongated along this line to indicate that it had been an open cleft at the time of their deposition.

In a single instance, in a radiating enstatite chondrule, there was noted a few minute inclosures of a blue-green mineral the like of which the writer has never before seen in a meteorite, and the exact nature of which can not be determined. The particles show no good crystal outlines nor cleavages such as would enable one to determine their orientation, optic axes, or extinction angles, and, except that they belong apparently to some inclined system, nothing can be said. The mineral is scarcely transparent and but faintly dichroic in yellow-green colors. More than anything else that can be recalled, it resembles the green hornblende inclosures sometimes found in pyroxenes in the older basic igneous rocks. In all the thin sections thus far prepared the mineral occurs in but a single instance.

So far as now known the total number of individuals comprising the Plainview fall is nine (including the two fragments), and the total weight 24,112 grams.



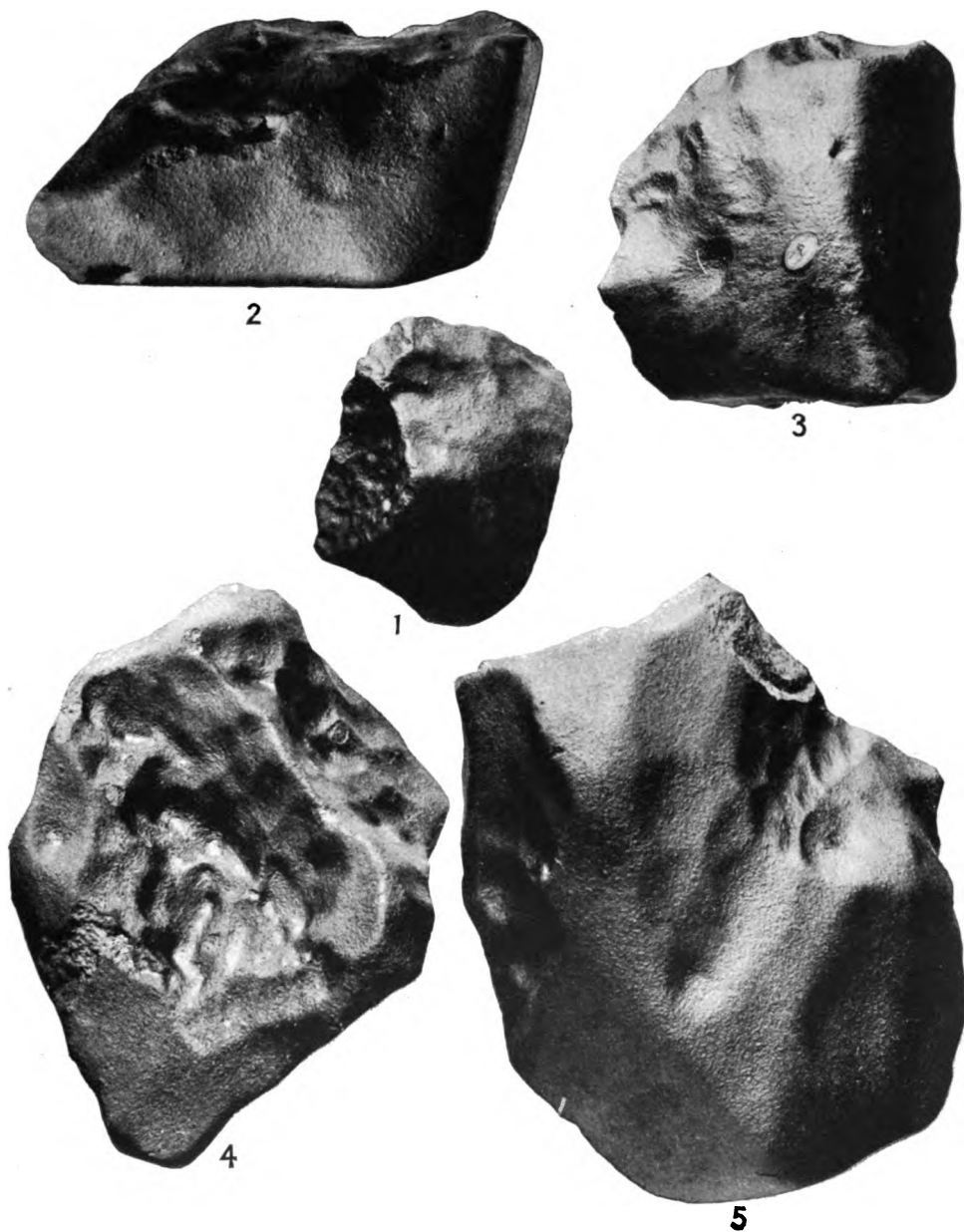
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METEORIC STONES FROM HALE COUNTY, TEXAS.

FOR EXPLANATION OF PLATE SEE PAGE 421.



METEORIC STONES FROM HALE COUNTY, TEXAS.

FOR EXPLANATION OF PLATE SEE PAGE 421.

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DESCRIPTION OF A NEW GOBY, *GARMANNIA SPONGICOLA* FROM NORTH CAROLINA.

By LEWIS RADCLIFFE,

Scientific Assistant, United States Bureau of Fisheries.

Along the coast of North Carolina south of Cape Hatteras, there are a number of fishing banks¹ similar in character to those located off Charleston, South Carolina. The largest of these lies about 21 miles south by west $\frac{1}{2}$ west of the bell buoy at the entrance to Beaufort, North Carolina, harbor in $13\frac{1}{2}$ to 15 fathoms of water. The bottom is hard and rocky in places and supports a growth of corals, sponges, and marine plants. The organisms found here are in the main characteristic of warmer, southern waters, the fauna bearing a marked similarity to that of the snapper banks off Pennsacola and Tampa, Florida.

The small species of goby described herein was taken in the course of an investigation of these grounds by the United States Fisheries Steamer *Fish Hawk* in August and September, 1914. It inhabits the cavities of large cuplike sponges.

GARMANNIA SPONGICOLA Radcliffe, new species.

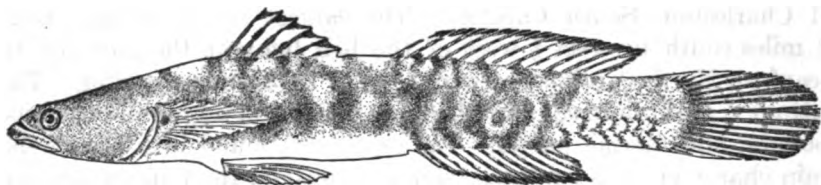
Dorsal VI-13; anal 11; body naked except for a small patch of large, strongly ctenoid scales about 22 in number on lower side and ventral surface of caudal peduncle; body long, slender, compressed posteriorly; depth 6.4 in standard length, 7.7 in total length; head long, slender, pointed 4.5 in standard length, 5.3 in total length; cheeks tumid; eye small, 6.9 in head, subdorsal; interocular space narrow, slightly concave, equal to diameter of eye; snout short, pointed, 4.1 in head; mouth large, slightly oblique, lower jaw included; maxillary long, 2.6 in head, extending beyond vertical from posterior margin of eye; teeth small, villiform; those in front of each jaw in several rows, unequal in size, longer ones recurved, caninelike; teeth on sides of jaws in a single row, gradually decreasing in size toward angles of mouth; several small, recurved caninelike teeth on underside of anterior margin of lower jaw.

¹ The Offshore Fishing Grounds of North Carolina, by Lewis Radcliffe. Economic Circular No. 8 of the Bureau of Fisheries, issued Feb. 26, 1914.

Dorsal fins prominent, without filamentous rays, widely separated, the first of six rather weak, slender spines; second dorsal elongate, free from caudal; caudal fin short, rounded; pectoral fins long, pointed, nearly as long as head; ventrals completely united, not adnate to the belly, equal to pectorals in length; anal similar in form to second dorsal, free from caudal.

Color in alcohol: Body Broccoli brown, with about 14, more or less indistinct vertical, sepia-colored cross bands; belly lighter in color, head darker, drab-colored; vertical fins mottled with darker; dorsals and anal with a darker marginal band; pectorals dusky at base, lighter distally; ventrals translucent.

Type.—Cat. No. 77501, U.S.N.M., a specimen 31 mm. long taken August 11, 1914, in 14½ fathoms with the beam trawl at *Fish Hawk*



1 in



GARMANNIA SPONGICOLA RADCLIFFE.

station 8212. This station lies about 1 mile southeast of the fishing buoy, on the largest fishing ground, the position of the buoy being latitude 34° 19' N.; longitude 76° 48' W. The sponge from which the type and cotypes were taken was 45.7 cms. in diameter at the top and 53.3 cms. high, cup-shaped.

Cotypes.—Fourteen specimens 20 to 28 mm. long. These vary somewhat in coloration from the type, some being much darker colored, others lighter; other than in intensity the color pattern is quite similar. Occasional examples have seven dorsal spines instead of six, and twelve dorsal rays instead of thirteen. The anal normally consists of ten rays.

Paratypes.—Six specimens 24 to 28 mm. long, taken August 1, 1914, at *Fish Hawk* station 8199, about 3 miles west-northwest of fishing buoy in 14½ fathoms.

The sponge from which these specimens were taken was deeply concave on top, cup-shaped, 61 cm. in diameter at top. According to Dr. H. V. Wilson this is presumably an undescribed species of *Spirastrella*.

In the collection of the Bureau of Fisheries are five specimens 17 to 27 mm. long taken by Mr. W. W. Welsh, January 13, 1913, 14 miles W. ½ N. from Anclote Light, Anclote Keys (near Tarpon

Springs) on the west coast of Florida. These specimens were taken from a large sponge similar in form to those from the North Carolina coast. The sponge was dredged by the *Fish Hawk* in 8½ fathoms on rough bottom.

This species is named *spongicola* in allusion to its habit of living in the cavities of sponges.

As the genus *Garmannia* has been characterized by species having the anterior half of the body naked, posterior half covered with moderate or small scales, its characters should be extended to cover the present species, in which the scaling is reduced to a small area on the lower side and ventral surface of the caudal peduncle.

A NEW SPECIES OF POLYCHAETOUS ANNELID FROM PANAMA, WITH NOTES ON AN HAWAIIAN FORM.

By AARON L. TREADWELL,
Of Vassar College, Poughkeepsie, New York.

Among the material received from time to time from the United States National Museum for identification, there was a new species of *Phyllodoce*, collected at Chame Point, Panama, by Mr. Robert Tweedlie in 1912, which is herewith described. A reexamination of material from the Hawaiian Islands, referred to *Eunice siciliensis* Grube in a former paper, makes it necessary to change the name which I then applied. This is done in the present paper, and additional data, resulting from a more detailed study, are presented.

LEODICE DUBIA Woodward.

Eunice dubia WOODWARD, Bull. Mus. Comp. Zool., vol. 51, No. 1, 1907, p. 11, pl. 2, fig. 15; pl. 1, figs. 4, 5, 6.

Eunice siciliensis TREADWELL, Bull. U. S. Fish Comm., 1903, p. 1165, 1906.

In the above paper I described as *Eunice siciliensis* a small Leodidid from the Hawaiian Islands. The identification was based mainly on the structure of the jaws, the mandibles having the large calcareous terminal portions characteristic of this species. Doubts as to the accuracy of the determination led to a reexamination of the specimen, now in the United States National Museum, and a comparison of the posterior end with Woodward's description of *Eunice* (*Leodice*) *dubia*, the small palolo of the "motosuga" day, or day before the swarming of the true Palolo, established its identity with this. Woodward saw only the swarming posterior ends but these were described with sufficient accuracy to identify them with the specimen from the Hawaiian Islands.

No gills were visible on this single specimen, and this would apparently transfer it to the genus *Nicidion*. On all of the members of this group of the Leodiciidae, however, as for instance, in *Leodice cariboea* of the West Indies, the gill development is very limited and the jaw structure is so characteristic of the *Leodice* that I have placed it in this genus.

The body was approximately 300 mm. long, with a head width of about 2 mm. Anteriorly the somites are broadly rounded dorsally, and flattened ventrally, with the parapodia at the ventro lateral angles. After about the first quarter of the body where, apparently, the sex products begin to appear, the ventral surface is rounded and the body assumes very nearly a circular cross section with the parapodia on the lateral edge.

The head is rather deeply incised by a V-shaped depression, each lateral half ending in a rounded point. The antennae had all been lost, and the peristomium was mutilated so as to show no indication of the character of the nuchal cirri. The eyes were oval in outline, situated in the usual position. Two pairs of anal cirri, one much larger than the other, are carried on the pygidium.

Parapodia from the anterior region of the body (fig. 3), show a rounded setal lobe with practically equal anterior and posterior lips, and two heavy brown aciculae. The dorsal cirrus is long, slender, finger-shaped, the ventral one orbicular, flattened. Two tufts of setae arise very close together, the dorsal ones simple, curved, without perceptible wings, but with the edges finely striated (fig. 4). Ventral setae compound, basal portion serrate along its apex, terminal joint with finely serrated sheath and subterminal tooth longer than terminal one (fig. 5). No pectinate setae appeared in any of the parapodia examined.

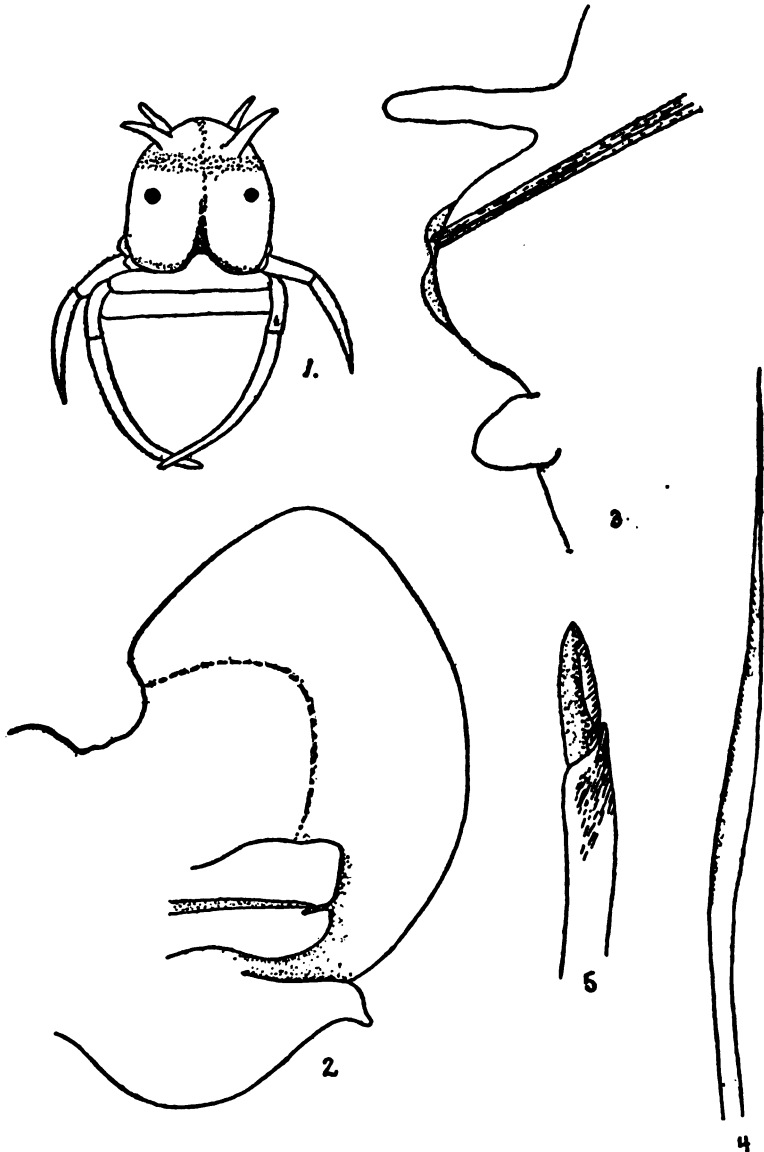
The posterior parapodia were as figured by Woodward. The setae lobes are slender and elongated, and the setae are essentially like those farther forward except that the basal portion of the compound setae is much elongated.

PHYLLODOCE PANAMENSIS, new species.

Description.—Head unusually broad as compared with length (fig. 1), the width behind antennae being nearly equal to that of posterior margin. Eyes situated about midway of the head, small, with very small lenses. A noticeable groove at middle of posterior margin, into which a lobe from the anterior margin of the first somite extends. Antennae about one-third as long as head, bluntly pointed at apex. There is a pigmented band around the head just posterior to the antennae, and a very narrow band of pigment along the posterior margin.

Tentacular cirri with rather long basal joints, the terminal joint of the first about equal in length to that of the ventral one on somite two. Dorsal cirrus of somite two equal to that of somite three, extending to somite nine. All cirri showed traces of pigment patches. Dorsal cirrus of somite four, leaf-like, but very small; those of succeeding somites increase rapidly in size to the eighth, while from here backward the increase is very gradual. All of the later cirri overlap one another, the exposed portion showing a broad pigmented band,

but leaving the margin uncolored. A broad band of this same pigment extends across the dorsal surface of each somite with a very delicate line of deeper pigment marking its anterior and posterior



FIGS. 1-5.—1, *PHYLLODOCE PANAMENSIS*, HEAD $\times 20$. 2, PARAPODIUM $\times 33$. *LEODICE DUBIA*, 3, ANTERIOR PARAPODIUM $\times 90$. 4, SIMPLE SETA $\times 370$. 5, COMPOUND SETA $\times 560$.

edges in the dorsal median line. Ventral cirri are much smaller with narrowed terminal portion and throughout middle and posterior portions of the body with very prominent pigment patches. The specimen was incomplete, retaining only about one hundred and twenty somites.

A well-developed parapodium has a bilobed end, the dorsal being the larger of the two lobes. Into the notch between the two extends the apex of a stout aciculum. Behind the lobes is a row of forty or more setae. The dorsal cirrus is ovate attached by a broad cirrophore (fig. 2). In this drawing it is represented as it appeared when flattened under the pressure of the cover glass. Ventral cirrus with rounded ventral margin and pointed apex.

Setae all compound; the basal portion expanded at the end, and carrying at this place a dense tuft of stout spines. Terminal portion slender, curved, with a row of teeth along one margin.

Width at head, 1.25 mm.; length of head, 1.25 mm.; total width, including parapodia, at somite five, 4 mm.; total width farther back, 6 mm.

Type.—Cat. No. 16831, U.S.N.M., was collected at Chame Point, Panama, by Robert Tweedlie, in 1912.

NOTICE OF A NEW PALEOCENE MAMMAL, A POSSIBLE RELATIVE OF THE TITANOTHERES.

By JAMES WILLIAMS GIDLEY,
Assistant Curator of Fossil Mammals, United States National Museum.

While recently in the vicinity of old Fort Union, (Buford), North Dakota, Dr. Vernon Bailey, of the United States Biological Survey, made an accidental discovery of a few associated fossil teeth and jaw fragments which he found in the bad land deposits, of Fort Union age (Paleocene) at that locality. This proves to be an important find, as the specimen represents a mammal of much larger size and apparently of different ordinal affinities than any hitherto reported from this horizon. The specimen has been kindly presented to the United States National Museum by Doctor Bailey, and is here described.

TITANOIDES, new genus.

Lower molars brachyodont-lophodont; with the W pattern characteristic of the Titanotheres but; with talonid less elevated than trigonid; paraconid elevated and well separated from the metaconid so that the anteroposterior diameter of the trigonid is but slightly less than its transverse; last molar largest, the series gradually diminishing in size forward; hypoconulid present in m_3 but this tooth has no true third lobe; premolar with molariform (i. e. V shaped) trigonid but with talonid rudimentary; jaw symphysis relatively short, wide and shallow, not sutured; canine, as indicated by a portion of the alveolus preserved, appears to have been of about the same relative size and position as in the Titanotheres.

Type of the genus.—*Titanoides primaevus*, new species.

TITANOIDES PRIMAEVUS, new species.

Plate 36, figs. 1, 2.

Type.—Lower m_2 and m_3 , anterior half on m_1 and $p(?)_1$, all of the right side; a portion of m_2 of the left side; and two portions of the jaw symphysis. (Cat. No. 7934 U.S.N.M. Coll.). While the teeth are all detached there is no reasonable doubt that they and the jaw portions belong to a single individual.

Type-locality.—Bad Lands, about 3 miles northeast of Buford (Fort Union of early days), North Dakota.

Horizon.—Paleocene, Fort Union formation (type section).

Diagnosis.—Teeth indicate an animal about the size of the smaller *Paleosyops* of the Bridger or of one of the smaller species of *Caenopus* of the Oligocene; talonid of last molar relatively elongated with large hypoconulid which shows distinct evidence of budding off to form a third lobe; talonid of molars relatively low and narrower than the trigonid; basal cingulum continuous except on lingual border of crowns, talonid of $p(?)_4$ rudimentary being little more than a cingulum cusp situated almost in line with the inner cusps row at the base of the metaconid; cusps of the trigonid, both in the molars and in p_4 , relatively high and pointed.

Measurements.

	Anteroposterior.	Transverse.
M_1	22.5+	15.5
M_2	27	19
M_3	32.8	19.4
$P_4(?)$	5	14.5

Discussion of characters and possible relationships.—The specimen constituting the type above described while very fragmentary fortunately is of a young adult in which only m_1 of the tooth series shows any degree of wear and all the teeth are well preserved, hence what characters they possess are not confused.

This species represents by far the largest mammal yet known from the Paleocene. The teeth are about one-third larger than those of the largest species of *Pantolambda* of this horizon, and about equal those of *Coryphodon simus* of the Wasatch or one of the smaller species of *Caenopus* of the Oligocene.

In the absence of other parts of the skeleton to substantiate the evidence of tooth characters, the ordinal position of this animal admittedly does not stand on unassailable grounds. However these teeth from the Fort Union seem certainly to be those of an ungulates and their general characteristics suggest Titanotheres affinities.

Compared in detail with the Titanotheres they present similarities, which, when the much older horizon and consequently more primitive stage of development is considered, are rather striking. These similarities consist in (1) the like relative proportions of the molars to each other in the series; (2) the correspondence in form and general contour of the triconid and talonid, both of which are V shaped and uniting form the W pattern characteristic of the Titanotheres lower molars; (3) the cingulum development is like that observed in those Titanotheres in which this element is present; and (4) the bone fragments show the lower jaw to be of heavy massive type, with broad, shallow and unsutured symphysis, while the canine and submental

foramen are in about the same relative positions respectively as in the Oligocene Titanotheres.

The principal differences observed are: (1) The relatively low and less transversely expanded talonid (in *Paleosyops* the talonid is also depressed, slightly in the molars, very pronouncedly in the premolars); (2) the somewhat greater angulation of the principal cusps of the trigonid; (3) the rudimentary condition of the talonid of p_4 ; and (4) the absence of a third, or heel lobe of the last molar. These morphological differences and especially the last two cited, are undeniably very considerable, yet it seems to me they may all be attributed to the more primitive stage in which we find the teeth of *Titanoides*.

In a general way the teeth of *Titanoides* also resemble those of the Amblypoda. Especially is this noticable in the form of the premolar, which is in the same stage of development as the corresponding one of *Coryphodon*. Comparing the teeth of *Titanoides* with those of *Pantolambda*, *Coryphodon*, and *Uintatherium*, however, they show the following important differences, and be it noted these same differences are observable in comparing the Titanotheres with the Amblypoda. In the Amblypoda the basal cingulum, when present, is confined to the anterior and posterior borders of the tooth crown, continuous in the Fort Union species; trigonid short, its anteroposterior diameter being much less than that of the talonid, trigonid and talonid about equal in length in *Titanoides*; paraconid small and low in *Pantolambda*, much depressed and vestigial in *Coryphodon*, and *Uintatherium* relatively high, prominent and well separated from the metaconid in *Titanoides*.¹ The Amblypoda are further distinguished (1) by the progressive tendency to depression of the anterior lophs of the trigonid and talonid respectively in *Pantolambda* and finally to their almost entire disappearance in *Coryphodon* and the *Uintatheres* where the teeth have developed two subequal cross lophs with an open valley between; and (2) by the development on the talonid of a low median shelf, or spur, which is incipient in *Pantolambda*, well masked in *Coryphodon* and the *Uintatheres*.

From the above it will be seen that, whether related to the Titanotheres or not, the teeth of *T. primaevus* have no amblypod characteristics, and the line of development marked out is evidently fundamentally different from that observed in the Amblypoda.

It is unfortunate that the upper dentition of *T. primaevus* is not known, since this series is usually more characteristic than the lower, and therefore more reliable for purposes of group determination. However, because of certain definite mechanical relationships between cusps of corresponding upper and lower cheek-teeth in mammals, the

¹ In the Chalkiotheres, which also resemble the Titanotheres in some respects, the paraconid is depressed while the entoconid is high and prominent.

main features of either series can be predicted with some degree of accuracy by a critical study of the opposing series. This is true especially as regards the number, relative size, general form and proportions of the principal cusps.

To those who have studied tooth structure it is well known that the trigonid of the lower molar bites on the inner side of the tooth row and between or over the interspaces of the molars of the upper series, in forms of the interlocking brachyodont type. The talonid, when present, is opposed to the protocone of the corresponding upper

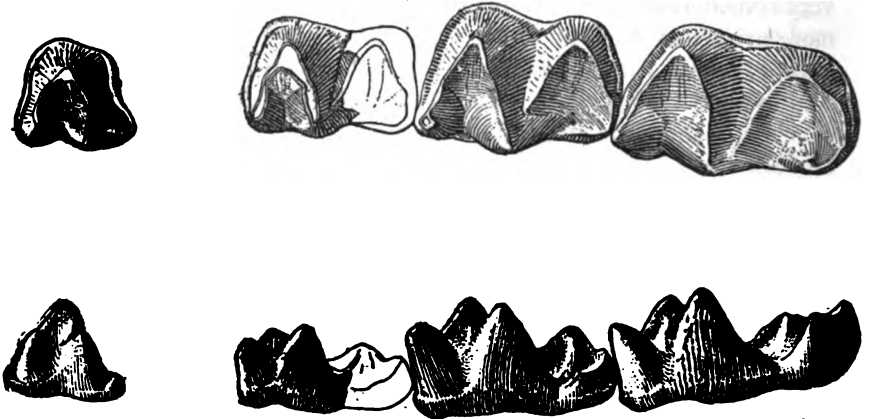


FIG. 1.—LOWER CHEEK-TEETH OF *TITANOIDES PRIMAEVUS*. NATURAL SIZE.

molar, and the development of the hypocone is always correlated with and contingent upon the development, in the lower series, either of the entoconid of the corresponding tooth or the paraconid of the next tooth behind. Also the hypoconid bites into the middle basin of the upper tooth crown between the paracone and the metacone.

Based on these known relations of cusps, I have attempted a construction in clay of the upper series (see fig. 2, pl. 36) of the side corresponding to the lower teeth of the type (see fig. 1, pl. 36). The details as worked out are of necessity largely conjectural and will probably prove incorrect. I feel considerably more confident, however, regarding the main features.

Thus constructed these upper teeth are decidedly titanotheroid in general form and structure. The principal characteristics obtained are: (1) The paracone and metacone are higher than the cusps of the inner row and are selenodont in form; (2) to conform with the two shallow basins of the lower molars, namely, the larger one of the talonid, and the smaller and higher one of the trigonid, all the upper molars have low, broad, conate protocones, and m^1 and m^2 small but well-defined hypocones; (3) p^4 and p^3 are wide and short, and are composed of two main cusps, the outer (paracone) high and the inner (protocone) low. If the lower premolar of the type is properly identified as p_4 , the p_4 above had probably not yet developed the

second main cusp of the outer row, since the former has no functional talonid.

While it is freely admitted that the foregoing observations on the possible structure of the upper cheek-teeth can not be submitted as evidence in the present case, they seem to lend some weight to the conclusions at which I have arrived concerning the probable affinities of this new mammal from the Fort Union.

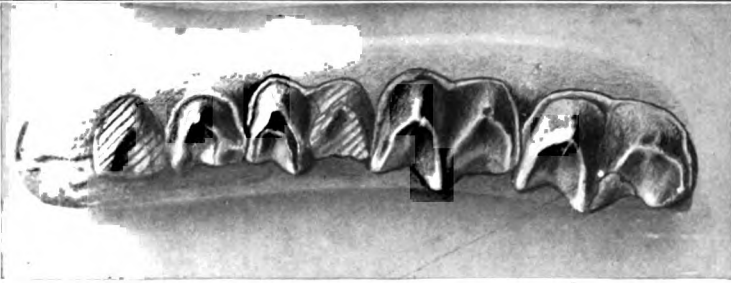
These conclusions may thus be briefly summarized: From the evidence at hand I conclude that *Titanoides primaevus* can not be classed with the Amblypoda, that it is probably a Perissodactyl, and certain features make it not improbable that it is rather closely related to the Titanotheres. Future discoveries, however, may prove that its relationship is so remote as to necessitate the establishment of a new family for the reception of this genus.

EXPLANATION OF PLATE 36.

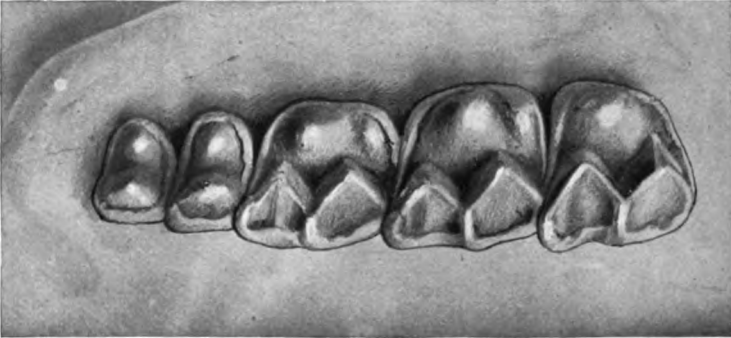
Fig. 1.—*Titanoides primaevus*, page 431. Crown view of lower cheek-teeth. Type, $\times \frac{1}{2}$ +. Cat. No. 7934 U.S.N.M. Coll.

Fig. 2.—Cast of restoration representing conjectural upper cheek-teeth of *Titanoides primaevus*. $\times \frac{1}{2}$ +. Page 434.

Fig. 3.—Bad Lands about 3 miles northeast of Buford, North Dakota. X indicates the spot where the type of *Titanoides primaevus* was found.



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A NEW PALEOCENE MAMMAL FROM NORTH DAKOTA.

FOR EXPLANATION OF PLATE SEE PAGE 435.

**MAMMALS COLLECTED BY DR. W. L. ABBOTT ON THE
CHAIN OF ISLANDS LYING OFF THE WESTERN COAST
OF SUMATRA, WITH DESCRIPTIONS OF TWENTY-EIGHT
NEW SPECIES AND SUBSPECIES.**

By **MARCUS WARD LYON, JR.,**
Of George Washington University, Washington, D. C.

INTRODUCTION.

Between the years 1901 and 1905 Dr. W. L. Abbott, in his zoological explorations of the Malay Archipelago, visited the chain of islands lying off the southern and western coast of Sumatra three times. On these expeditions he collected over 800 specimens of mammals, all of which were presented to the United States National Museum. No general paper covering the mammals of this group of islands as a whole, or covering Doctor Abbott's collections as a whole from the islands that he explored has appeared. A few papers on the mammals of individual islands have been printed (Modigliani, 1889; Thomas, 1894*a*; Miller, 1903*a*, 1906; Andersen, 1906; Lyon, 1908), and the collections made by Doctor Abbott, have been studied in part by Miller (1903*a*, 1903*b*, 1906*a*, 1906*c*, 1911, 1913); Andersen (1905, 1912), Elliot (1910) and Lyon (1913). Two of the most interesting primates discovered in recent years were found among them (Miller, 1903*b*).

About two years ago Mr. Gerrit S. Miller, jr., suggested that I make a study of the mammals of this region. Since then I have been engaged in this investigation during my leisure time. It now seems desirable to publish descriptions of the 28 new forms that examination of the collections has revealed. A list of the islands that Doctor Abbott has visited with the species that have been found on each is appended.

The references given at the end are the more important ones that have appeared dealing with the mammals that Doctor Abbott has collected, and with those of other collectors. They will serve as a guide to the place of publication of the forms listed under the islands.

DESCRIPTIONS OF NEW SPECIES OF MAMMALS.

Order CHIROPTERA.

Family PTEROPIDAE.

CYNOPTERUS BABI, new species.

1903. *Cynopterus titthaechellus*, MILLER, Proc. U. S. Nat. Mus., vol. 26, p. 474, February 3, 1903.

Type-specimen.—No. 114269, U.S.N.M., skin and skull, collected on Pulo Babi, January 8, 1902, by Dr. W. L. Abbott, original number 1411.

Geographic distribution.—Pulo Babi, possibly it may also occur on Pulo Simalur and Pulo Lasia.

Diagnostic characters.—A medium-sized member of the genus (forearm 66 to 68 mm., condylobasal length of skull about 30), of very dark color, darker than *Cynopterus scherzeri* of the Nicobar Islands.

Color.—Upperparts of head, neck, body, small interfemoral area, and haired area of arm and forearm, between bone brown and natal brown, darker anteriorly on the head, and lighter posteriorly; at base hairs are deep mouse gray; underparts olive brown, except on throat, which is dark olive brown or an isabella color; the color of the throat extends up on sides of neck; membrane above and below, including the skin over the finger bones, blackish brown; ear blackish brown with margin as dark as rest of ear.

Skull and teeth.—The skull closely resembles that of *Cynopterus brachyotis* of the Sumatran mainland, as well as that of *C. scherzeri*; it is slightly narrower and the post-orbital constriction is more marked (*schерzeri*, 6 mm., Tarussan Bay *brachyotis*, 6 to 7 mm., *babi*, 5 to 5½ mm.). The teeth do not show any distinguishing characters.

Measurements.—Type: Head and body, 95 mm., expanse 460 (both collector's measurements), forearm 67; thumb, 26; second digit, 46; third digit, 43 by 28 by 37; fourth digit, 41 by 21 by 24; fifth digit, 41 by 20 by 21; tibia, 26; foot, 16; skull, greatest length, 30; condylobasal length, 29.2; zygomatic width, 19; width of brain case, 13; width of palate including outsides of teeth, 9.3; width of palate at posterior free margin, 5.3; antorbital constriction, 6.2; postorbital constriction, 5.5; maxillary tooththrow, 10.2; mandibular tooththrow, canine to last molar, 11.5.

Specimens examined.—Three, all from Pulo Babi; skin and skull of the type and two in alcohol.

Remarks.—The dull color of the species is apparently very characteristic and is as noticeable in the wet alcoholics as in the skin. There

is no lightening of the skin covering the wing bones as so frequently happens in the case of *Cynopterus*. Belonging to a genus which shows comparatively little differentiation among its members, *Cynoterus babi* has no specially striking peculiarities to indicate its affinities. On account of its having the same general size and a uniformly dark color, it is apparently more closely related to *C. scherzeri* than to the Sumatran *C. brachyotis*. It is unfortunate that there are no specimens of *Cynopterus* from Simalur and also from the Banjak Islands.

Family MEGADERMIDAE.

MEGADERMA LASIAE, new species.

1903. *Megaderma spasma*, MILLER, Proc. U.S.Nat.Mus., vol. 26, p. 474, February 3, 1903.

Type-specimen.—No. 114249, U.S.N.M., skin and skull, collected on Pulo Lasia, January 6, 1902, by Dr. W. L. Abbott, original number 1401.

Geographic distribution.—Lasia and Babi Islands.

Diagnostic characters.—A large member of the genus characterized by the width of rostrum and the solidly built portion of the maxilla covering roots of canines.

Color.—Type: Free ends of hairs of upper parts benzo brown or near that color, or between that and hair brown; base of hairs, mouse or light mouse gray; under parts, generally similar but somewhat lighter. Ears and membrane blackish brown except tips of wings which are lighter.

Skull and teeth.—The skull as a whole is slightly larger than that of *Megaderma trifolium* of Sumatra and Java, the rostrum being particularly wide and heavy with roots of canines very heavy, best seen on viewing skull from above. The teeth as a whole are larger than they are in *M. trifolium*, particularly the large premolar and first molar.

Measurements.—Type: Head and body, 80 mm.; forearm, 59; tibia, 34; foot, 20; width of rostrum at apex, 64; condylobasal length, 24.5; brain case, 11.6; maxillary toothrow, 10.

Specimens examined.—Four from Pulo Lasia, two from Babi.

Remarks.—*Megaderma lasiae* is readily distinguishable from the Sumatran-Javan form, but appears to be closely related to *M. natunae*,¹ but is not so large.

MEGADERMA SIUMATIS, new species.

Type-specimen.—No. 114227 U.S.N.M., skin and skull of adult female, collected on Pulo Siumat, December 27, 1901, by Dr. W. L. Abbott; original number 1390.

¹ Andersen and Wroughton, Ann. Mag. Nat. Hist., ser. 7, vol. 19, p. 123, February, 1907.

Geographic distribution.—Siumat Island, and probably Simalur.

Diagnostic characters.—A medium-sized member of the genus somewhat intermediate between *Megaderma trifolium* and *Megaderma lasiae*, particularly with respect to portion of maxilla covering root of canine.

Color.—Type: Upper parts of body, free ends of hairs similar to benzo brown, basal portions deep quaker drab, under parts of same general style of coloration but lighter, the free ends of the hairs becoming mouse-gray; the hairs about the head and upper parts of neck incline to buffy brown, ears and membranes blackish brown except tips of wings lighter.

Skull and teeth.—The skull for the most part is essentially like that of *Megaderma trifolium*, but is slightly heavier, especially about the rostrum, the roots of the canines are distinctly larger and heavier, but not nearly so enlarged as they are in *Megaderma lasiae*. The entire skull is distinctly smaller than that of the latter species. Aside from the enlarged roots of the canines the teeth of *Megaderma siumatis* are plainly like those of *M. trifolium*, and much smaller than those of *M. lasiae*.

Measurements.—Type: Head and body, 75 mm.; forearm, 59; tibia, 32; foot, 19; width of rostrum at apex, 22.5; condylobasal length, 10.4; maxillary toothrow, 9.5.

Specimens examined.—Three, all from Pulo Siumat.

Remarks.—In view of the closeness of Siumat to the large island Simalur it is not unlikely that *Megaderma siumatis* occurs on both islands. It may be rather closely related to Sumatran examples of *M. trifolium*, of which there are no specimens in the United States National Museum, comparisons having been made with Javan and Peninsular examples.

MEGADERMA NIASENSE, new species.

Type-specimen.—No. 141305, U.S.N.M., adult male, preserved in alcohol, collected on Pulo Nias (Mojeia River), March 15, 1905, by Dr. W. L. Abbott; original number 4066.

Geographic distribution.—Nias Island.

Diagnostic characters.—One of the smallest members of the genus, forearm 55 mm., greatest length of skull, 25.5; portions of maxillae covering roots of canines rather slender.

Color.—(Specimen dried from alcohol.) Tips of hairs of upper parts, hair brown to drab, bases of hairs deep quaker drab, hairs of underparts similar but in general lighter; membranes in general something like warm sepia, except for distinctly lighter tips of wings; ears same general color as membranes but lighter.

Skull and teeth.—The skull for the most part is essentially similar to that of *Megaderma trifolium*, but is slightly less heavy, with portion

of maxilla covering roots of canines less enlarged; zygoma more slender; audital bullae smaller; teeth are slightly smaller and toothrow shorter.

Measurements.—Type: Head and body, 65 mm.; forearm, 55; tibia, 32; foot, 17; width of rostrum at apex, 5.2; condylobasal length, 22.5; width of braincase, 10.3; maxillary toothrow, 9.2.

Specimens examined.—One, the type.

Remarks.—*Megaderma niasense* is apparently the smallest member of the genus. It is conspicuously smaller than the other species from the Barussan Islands, but the smallest individuals of *Megaderma trifolium* closely approximate it in size.

Family VESPERTILIONIDAE.

MYOTIS ABBOTTI, new species.

Type-specimen.—Preserved in alcohol, skull removed, adult female, No. 121611, U.S.N.M., collected on North Pagi Island, January 3, 1903, by Dr. W. L. Abbott; original number 2191.

Geographic distribution.—Only known on North Pagi Island, but probably occurring on South Pagi as well.

Diagnostic characters.—A member of the *muricola* group of *Myotis*, distinguished by its distinctly larger size.

Color.—Fur of upperparts with general effect of mummy-brown, bases of hairs blackish-brown, and showing through to a moderate extent; fur of underparts, light buffy-brown, with the blackish-brown bases showing through to a considerable extent; membranes and ears varying between natal and bone-brown.

Skull and teeth.—Compared with the skull of *Myotis muricola* (Sumatran specimens) the skull of *M. abbotti* is distinctly larger throughout and more angular, especially about the rostrum; the braincase is relatively more swollen than that of *M. muricola*. The teeth of *M. abbotti* are like those of *M. muricola*, only larger.

Measurements.—Type, and paratype No. 121610: Forearm, 38, 38 mm.; tibia with foot, 27, 26.5; tibia alone, 16.8, 17.2; ear from crown, 11.5, 11.5; condylobasal length of skull, 13.8, 13.5; interorbital constriction, 3.8, 3.8; width of braincase, 7.4, 7.4; maxillary toothrow, including canine, 5.5, 5.5.

Remarks.—*Myotis abbotti* appears to be a well characterized form, distinguishable at a glance from *M. muricola* by its longer forearm, greater size of skull, and more swollen braincase. Its great differentiation is in agreement with that of many of the other mammals of the Pagi Islands.

MYOTIS NIASENSIS, new species.

Type-specimen.—Preserved in alcohol, skull removed. No. 121876, U.S.N.M., adult female, collected by Dr. W. L. Abbott at Siaba Bay, Nias Island, March 20, 1903; original number 2402.

Geographic distribution.—Known only from Nias Island.

Diagnostic characters.—A small form of *Myotis muricola*. (Comparison with Sumatran examples.)

Color.—Fur of upperparts cinnamon-brown, the blackish-brown bases of the hairs showing through to a moderate extent; fur of underpart avellaneous, almost whitish under chin; dark bases of the hairs of underparts show through to a very considerable extent; membranes varying between natal and bone-brown; ears, tawny olive. The color of *Myotis niasensis* is distinctly lighter than that of either *M. muricola* or *M. abbotti*.

Skull and teeth.—Compared with the skull of *M. muricola* (Sumatran specimens) that of *M. niasensis* is distinctly smaller, though it has the same general shape; it lacks the roundness of braincase seen in *M. abbotti* and the angularity of the rostrum.

Measurements.—Type, paratype No. 121877 and an average specimen, No. 141134 of *Myotis muricola* from Tarussan Bay, Sumatra: Forearm, 31.2, 31.5, 34.5; tibia, including foot, 19, 18.5, 22.5; tibia alone, 14, 13.5, 16.4; ear from crown, 10.2, 9.8, 11; condylobasal length of skull, 12.6, 12.4, 13.3; width of braincase, 6.3, 6.4, 6.6; interorbital constriction, 3.2, 3.2, 3.2; maxillary toothrow, including canine, 4.6, 4.8, 5.2.

Remarks.—*Myotis niasensis* is a well-marked form of *Myotis muricola* but less highly differentiated than the *Myotis* from Pagi Islands. It is easily distinguished from the parent form by its smaller external cranial and dental measurements, and by its lighter color.

Order CARNIVORA.

Family VIVERRIDAE.

PARADOXURUS HERMAPHRODITUS ENGANUS, new subspecies.

1894. *Paradoxurus hermaphroditus*, THOMAS, Ann. Mus. Civ. Stor. Nat., Genova, ser. 2, vol. 14, p. 105.

1906. *Paradoxurus hermaphroditus*, MILLER, Proc. U. S. Nat. Mus., vol. 30, p. 820, June 4, 1906.

Type-specimen.—No. 141026, U.S.N.M., skin and skull of adult female (maxillary teeth much worn), collected on Engano Island, November 11, 1904, by Dr. W. L. Abbott; original number 3782.

Geographic distribution.—Engano Island.

Diagnostic characters.—A small form of the widely ranging *Paradoxurus hermaphroditus*, its size the same as that of *P. hermaphroditus parvus*, but distinguished by a less rounded brain case, somewhat smaller teeth, a longer (antero-posteriorly) upper canine, and probably by brown or lighter colored hind feet.

Color.—Aside from the feet the color of *Paradoxurus hermaphroditus enganus* does not differ from that of *P. h. parvus*. The single

specimen is of the brownish type of coloration. The brown color of the hind feet may be the result of wear as the brown hairs covering them look worn; the entire tail is brownish, but is obviously worn.

Skull and teeth.—Aside from certain differences these are essentially as they are in *Paradoxurus hermaphroditus parvus*, the distinguishing features being the conspicuous narrowness and less inflation of the brain case, the heavier mandibular condyle, the general smaller size of the teeth, and the greater antero-posterior diameter of the upper canine.

Measurements.—Type: Head and body, 495 mm., tail, 410; hindfoot, 77; condylobasal length, 97; zygomatic width, 53; width of brain case, 32; maxillary toothrow 35.6; width of brain case at level of coronal suture 25.4 mm., same measurement in an adult female of nearly equal age of *Paradoxurus hermaphroditus parvus*, 28.8.

Specimens examined.—One, the type.

ARCTICTIS NIASENSIS, new species.

Type-specimen.—No. 141230, U.S.N.M., imperfect pelt, collected on Nias Island in 1905 by Dr. W. L. Abbott; original number 3970. "Flat skin bought of native who had killed it in the hills near Fadoro, said not to be common."—W. L. A.

Diagnostic characters.—Distinguished from a fairly large number of Malay bear-cats by having tips of certain of the hairs of upper parts and the under parts ochraceous tawny instead of buff to ochraceous buff.

Color.—Upper parts of back of head, neck, body, and all of tail, brownish black, coarsely and rather sparsely grizzled with ochraceous tawny on the lower back, sides, outside of legs, and proximal two-thirds of tail; under parts tawny ochraceous.

Measurements.—Base of tail to ear, 580 mm.; tail, 540.

Specimens examined.—One.

Remarks.—The tawny coloration of the grizzling and of the under parts is not seen in a rather large series of Malay skins of *Arctictis binturong*, and there seems little doubt as to the distinctness of the Nias animal. It is a great misfortune not to have a perfect specimen, but imperfect as it is, it does not match any of the others. Dr. Abbott says that from the natives' descriptions of this animal it is undoubtedly a distinct form.

Order RODENTIA.

Family SCIURIDAE.

SCIURUS MANSALARIS BATU, new subspecies.

Type-specimen.—Skin and skull of adult male, No. 121732, U.S.N.M., collected on Tana Bala, Batu Islands, February 4, 1903, by Dr. W. L. Abbott; original number 2217.

Geographic distribution.—Tana Bala and Tana Masa of the Batu Islands, and probably other islands of the same group.

Diagnostic characters.—A subspecies of *Sciurus mansalaris* with relatively dark upper parts, resembling those of *S. m. mansalaris*, but under parts distinctly washed with buffy, slightly more than in the case of *S. m. bancarus*; light subterminal annulation of long hairs of tail narrower and more buffy, and less whitish than in the case of the other two races.

Measurements.—Type: Head and body, 160 mm.; tail, 100; hind foot, 37; condylobasal length, estimated, 35; zygomatic width, estimated, 24; width of brain case, 18; maxillary tooth row, 7.

Specimens examined.—Six skins and skulls from Tana Bala, and two from Tana Masa.

Remarks.—This is a rather poorly characterized geographic race, somewhat intermediate in many respects between the typical form and *Sciurus mansalaris bancarus* Miller of Pulo Bankaru. The recognition of the others makes that of the Batu squirrel imperative, as it can not be perfectly associated with the Mansalar or Bankaru forms.

RHINOSCIURUS INCULTUS, new species.

1903. *Rhinosciurus laticaudatus*, MILLER, Proc. U.S.Nat.Mus., vol. 26, p. 458, February 3, 1903.

Type-specimen.—No. 114414, U.S.N.M., skin and skull, adult female, collected on Pulo Tuanku, Banjak Island, February 5, 1902, by Dr. W. L. Abbott; original number 1515.

Geographic distribution.—Known only from Pulo Tuanku.

Diagnostic characters.—Closely related to *Rhinosciurus tupaoides*¹ (Malay Peninsula, Singapore), *R. peracer*² (Perak), *R. leo*² (Singapore), *R. robinsoni*³ (Tioman Island), *R. rhionis*² (Rhio Archipelago), *R. laticaudatus*⁴ (Borneo); characterized by general dull, dark coloration; ochraceous buff fringe on tail, absence of shoulder stripe; dull buffy underparts, long, slender rostrum, moderate sized bullae, large teeth.

Color.—Upper parts, head, neck, and body, and outside of legs a mixture of blackish and ochraceous orange, the darker color much in excess, especially in middle of back, and the lighter color tending toward yellow ochre about the head and neck; underparts, including inside of legs, dull whitish or buffy, sparsely admixed with a few brownish hairs; tail with about the same colors as the back, but the light and dark elements very coarsely mixed and in about equal proportions, the light color of the tail becoming ochraceous buff, which forms a fairly well-defined fringe around it.

¹ Blyth, Journ. Asiat. Soc. Bengal, vol. 24, 1855, p. 477.

² Thomas and Wroughton, Ann. Mag. Nat. Hist., ser. 8, vol. 3, p. 440, May, 1900.

³ Thomas, Journ. Fed. Malay States Mus., vol. 2, p. 104, October 10, 1908.

⁴ Müller and Schlegel, Verh. Nat. Gesch. Nederl. Overz. Bezitt. Eekhoorns, 1842, pp. 87, 100, pl. 15.

Skull and teeth.—Skull large and long, with long, slender rostrum, bullae of moderate size; not unusually small or large, maximum length 11 mm., teeth large and heavy, maxillary toothrow 12.5; maximum width of toothrow, 3.2.

Measurements.—Type: Head and body, 230 mm.; tail, 130; hind foot, 45; condylobasal length, 53.8; zygomatic width, 28.3; width of braincase, 23; interorbital constriction, 13.4; maximum length of nasals, 22; maxillary toothrow, 12.5.

Specimens examined.—One, the type.

Remarks.—*Rhinosciurus incultus* is not a highly characterized form, and is here described as new largely because of inability to assign it to any of the numerous named forms of the original *Sciurus laticaudatus*. Material in the United States National Museum for making comparisons of this group is extremely meager, and the descriptions of some of the forms are lacking in detail. As nearly as can be made out from the descriptions the following are the characters of the other members of this group.

Laticaudatus, Borneo, light colored animal, with moderately large skull, rostrum and bullae.

Tupaoides, Singapore and Malay Peninsula, tail washed with white instead of buffy, belly white, flanks buffy.

Robinsoni, Tioman Island, tail washed with buffy, bullae smaller than in *laticaudatus*, and much smaller than in *tupaoides*.

Peracer, Perak, Malay Peninsula, tail washed with buffy, relatively small bullae, about as in *laticaudatus*.

Leo, Singapore, and Malay Peninsula, like *peracer*, but brighter colored, and with very large bullae, distinguishing it from all the others.

Leo rhionis, Karimon, Kundar, Batam, and Bintang Islands, like *leo* but with better shoulder stripes and more buffy underparts.

RATUFA PALLIATA BATUANA, new subspecies.

1908. *Ratufa palliata*, LYON, Ann. Mag. Nat. Hist., ser. 8, vol. 1, p. 137, February, 1908.

Type-specimen.—Skin and skull of adult male, No. 121707, U.S. N.M., collected on Tana Bala of the Batu Islands, February 11, 1903, by Dr. W. L. Abbott; original number 2263.

Geographic distribution.—Known only from Tana Bala and Tana Masa of the Batu Islands.

Diagnostic characters.—A form of *R. palliata* characterized by its smaller size and in the possession of *palliata* type of nasal and premaxillary, and not of the *laenata* type; that is, the posterior end of the nasals and of the nasal branches of the premaxillaries lie on about the same straight line and the combined anterior median projections of the maxillaries, not unusually narrow.

Color.—Type: In good pelage, top of head and neck and upper parts of sides of same, including ears, outer side of fore and hind legs and feet, blackish brown; back, shoulders to rump, brown, lightening to a buffy isabella color on sides; underparts including lower part of sides of head and neck and inner sides of forelegs, and a rather narrow portion of inner side of hind legs, cream color, sharply contrasted with the blackish of head, neck, and legs, and moderately contrasted with the isabella-colored sides; tail above, a coarse mixture of cream color and brownish, the lighter color much in excess except at base and tip; underside of tail similar, but the cream color more prominent at the edges and the dark brownish more conspicuous next to the median line, the median line being light ochraceous, slightly mixed with brownish.

Skull.—Relatively small, posterior edge of nasals and nasal branches of premaxillaries on same line, and combined anterior median projections of maxillaries, not unusually narrow.

Measurements.—Type: Head and body, 330 mm.; tail, 385; hind-foot, 80; condylobasal length of skull, 63; zygomatic width, 42; post-orbital constriction, 23; orbital constriction, 22; width of braincase, 29; maxillary tooththrow, 13.5; mandibular tooththrow, 14; weight, 3 pounds, equals 1.36 kilograms.

Specimens examined.—Five from Tana Masa and nine from Tana Bala Islands of the Batu group in United States National Museum, and three from Tana Masa in the British Museum. No ratufas of this group were collected on Pulo Pinie of these islands.

Remarks.—*Ratufa palliata batuana* is not a well-marked form, it is essentially an intermediate between the typical form and *R. p. laenata*, having the skull form of one and the size of the other. Three specimens from Tana Masa Island were identified by me in 1908¹ as "not quite typical of *Ratufa palliata*." At that time attention was called to their smaller size. The subsequent careful examination of two additional specimens from Tana Masa and nine from Tana Bala leaves no doubt as to the advisability of recognizing the Batu *palliata* giant squirrel as a distinct geographic race. They were called by Wroughton in 1910² *R. palliata laenata*.

Family MURIDAE.

RATTUS SIMALURENSIS LASIAE, new subspecies.

Type-specimen.—No. 114254, U.S.N.M., skin and skull of adult female, collected on Pulo Lasia, January 6, 1902, by Dr. W. L. Abbott; original number 1400

Geographic distribution.—Pulo Lasia.

¹ Ann. Mag. Nat. Hist., ser. 8, vol. 1, p. 137, February, 1908.

² Journ. Bombay Nat. Hist. Soc., vol. 19, p. 805, February 26, 1910.

Diagnostic characters.—Distinguished from the typical subspecies and the next by having a short, wide, heavy rostrum, temporal ridges better developed and more angular, upper parts in many specimens, with a tendency to be dark and blackish.

Color.—Essentially like that of *Rattus simalurensis simalurensis* (Miller) (1903a) aside from the tendency already mentioned to darkness on upper parts.

Skull and teeth.—The skull is distinguished by its heaviness and angularity, especially seen in the wide heavy rostrum, and the heavy angular temporal ridges. While these characters are those usually produced by age, yet they are not found in examples of *Rattus simalurensis simalurensis* of equal age. Young examples show a wider rostrum than is found in young examples of the Simalur and Siumat rat.

Measurements.—Type: Head and body, 231 mm.; tail, 225; hind foot, 42; condylobasal length, 47.8; zygomatic width, 24.4; brain case, 17.7; maxillary tooth row, 7.9.

Specimens examined.—Thirteen from Pulo Lasia.

RATTUS SIMALURENSIS BABI, new subspecies.

Type-specimen.—No. 114280, U.S.N.M., skull, without skin, of adult male, collected on Pulo Babi, January 13, 1902, by Dr. W. L. Abbott.

Geographic distribution.—Pulo Babi.

Diagnostic characters.—Similar to the rat of Pulo Lasia, but with a heavy elongated skull.

Color.—Skins of the two specimens collected were not saved, the labels accompanying the skulls read: "Large gray rat similar to that of Pulo Lasia" for Cat. No. 114280, and for the other specimen Cat. No. 114281, collected a day later, "Large brown rat similar to that of Pulo Lasia."

Skull.—The skull is heavy but lacks the breadth and angularity of that of *Rattus simalurensis lasiae*, rostrum is moderately long and slender, temporal ridges are not angular, but are well defined and are inclined to appear somewhat parallel.

Measurements.—Type: Head and body, 255 mm.; condylobasal length, 50.2; zygomatic width, 23; width of brain case, 17.4; maxillary tooth row, 8.3. The tail of the type-specimen was imperfect; what there was of it measured 205 mm., tail of the other specimen, 217.

Specimens examined.—Two skulls without skins.

RATTUS BALMASUS, new species.

Type-specimen.—No. 121765, U.S.N.M., skin and skull of adult female, collected on Tana Bala, Batu Islands, February 13, 1903, by Dr. W. L. Abbott; original number 2286.

Geographic distribution.—Islands of Tana Bala and Tana Masa.

Diagnostic characters.—A member of the *Rattus firmus* group distinguished by somewhat small size, short tail, more yellowish type of coloration, and skull relatively slender, especially rostral portion.

Color.—Upper parts and sides of head, neck, and body, and outside of legs a coarse grizzled mixture of blackish brown, and a color somewhat like cinnamon-buff, both colors about equally mixed, the lighter color perhaps slightly in excess along the sides. Under parts, including inner sides of legs, dirty cream color, stained artificially along the throat with a rusty tinge, hairs not slaty at base.

Skull and teeth.—The skull of *Rattus balmasus* averages somewhat smaller than that of most of the other members of the *firmus* group; it is relatively narrow and has a relatively slender rostrum.

Measurements.—Type: Head and body, 222 mm.; tail, 201; hind-foot, 44; condylobasal length, 47; width of brain case, 18; maxillary tooth row, 9.5.

Specimens examined.—Three from Tana Masa and 7 from Tana Bala.

Remarks.—This species is very closely related to *Rattus pinatus* of Pulo Pinie; the difference between the two being scarcely more than subspecific.

RATTUS PINATUS, new species.

Type-specimen.—No. 121778, U.S.N.M., skin and skull of adult male, collected on Pulo Pinie, Batu Islands, March 4, 1903, by Dr. W. L. Abbott; original number 2367.

Geographic distribution.—Pulo Pinie.

Diagnostic characters.—A member of the *Rattus firmus* group, distinguished by somewhat small size, rather short tail, more yellowish type of coloration, and skull with a rather heavy rostrum.

Color.—The color of this species is so exactly like that of *Rattus balmasus* from Tana Bala, and Tana Masa that no further remarks are needed.

Skull and teeth.—The skull of *Rattus pinatus* averages somewhat smaller than that of most of the other members of the *R. firmus* group and is marked by a wider, stouter rostrum.

Measurements.—Type: Head and body, 218; tail, 200; hind foot, 46; condylobasal length, 48.3; width of brain case, 18.5; maxillary tooth row, 9.6.

Specimens examined.—Five, from Pulo Pinie.

Remarks.—This species is very closely related to its relative of Masa and Bala Islands, both forms together constituting a group apart from the other members of the *firmus* group.

RATTUS LINGENSIS BANACUS, new subspecies.

1903. *Mus lingensis* MILLER, Proc. U. S. Nat. Mus., vol. 26, p. 463, February 3, 1903.

Type-specimen.—No. 114294, U.S.N.M., skin and skull of adult male, collected on Pulo Bankaru, Banjak Islands, January 19, 1902, by Dr. W. L. Abbott; original number 1434.

Geographic distribution.—Pulo Bankaru, Banjak Islands.

Diagnostic characters.—General coloration rather dull (light markings on hairs ochraceous buff to dull ochraceous orange; underparts dull whitish, apparently stained; collar nearly always present, dark and light colors of sides and underparts so mixed as to produce a coarse speckled effect.

Measurements.—Size slightly smaller; head and body of adults, 190 to 205 mm.; tail, 160 to 175; hindfoot, 40 to 43; condylobasal length of skull, 41 to 43; width of braincase, 16.4 to 16.8; maxillary tooththrow, 6.4 to 7.4.

Specimens examined.—Thirteen from Pulo Bankaru.

Remarks.—This rat is very similar to its relative on Tuanku but averages distinctly duller; from typical *Rattus lingensis* it is chiefly distinguished by the coarse speckled appearance of the upperparts and sides, and by its somewhat shorter tail.

RATTUS LINGENSIS ANTUCUS, new subspecies.

1903. *Mus lingensis*, MILLER, Proc. U. S. Nat. Mus., vol. 26, p. 463, February 3, 1903.

Type-specimen.—No. 114390, U.S.N.M., skin and skull of adult female, collected on Pulo Tuanku, Banjak Islands, January 28, 1902, by Dr. W. L. Abbott; original number 1484.

Geographic distribution.—Pulo Tuanku, Banjak Islands.

Diagnostic characters.—General coloration moderately bright (light markings on hairs ochraceous buff to ochraceous orange), collar nearly always lacking, underparts dull whitish, the coarse speckled effect of the Bankaru rat lacking.

Measurements.—Size slightly smaller; head and body, 175 to 205 mm.; tail, 135 to 160; hindfoot, 37 to 40; condylobasal length of skull, 38 to 43; width of braincase, 15.5 to 17; maxillary tooththrow, 6.5 to 7.2.

Specimens examined.—Eleven from Pulo Tuanku.

Remarks.—This rat is distinguished from its relative on Bankaru by its somewhat brighter color, less conspicuous coarse speckling; from *Rattus lingensis*, by its more marked speckling and by its distinctly shorter tail.

RATTUS LINGENSIS MARALUS, new subspecies.

Type-specimen.—No. 121825, U.S.N.M., skin and skull of adult female, collected on Tana Masa, Batu Islands, February 19, 1903, by Dr. W. L. Abbott; original number 2310.

65008°—Proc.N.M.vol.52—17—29

Geographic distribution.—Tana Masa and Tana Bala, Batu Islands.

Diagnostic characters.—General coloration bright, but less so than in case of the Pinie rat (light markings on hairs ochraceous orange), light and dark colors of upperparts and sides so arranged as to produce coarse speckling, but dark color somewhat in excess, making animal appear darker than in case of the Pinie form; collar may or may not be present; underparts white.

Measurements.—Size moderate, head and body, 190 to 225 mm.; tail, 150 to 175; hindfoot 41 to 43; condylobasal length of skull, 40 to 44.5; width of braincase, 16.5 to 17.3; maxillary tooththrow, 6.5 to 7.2.

Specimens examined.—Five from Tana Masa and six from Tana Bala.

Remarks.—It is apparently impossible to distinguish between the *rajah* rats from Pulos Tana Masa and Tana Bala. Of the four skins from Masa two have complete collars, while in the other two it is barely indicated; both of the Bala skins have well-defined collars rather brighter than in the case of the two Masa specimens.

RATTUS LINGENSIS PINACUS, new subspecies.

Type-specimen.—No. 121846, U.S.N.M., skin and skull of adult female, collected on Pulo Pinie, Batu Islands, March 2, 1903, by Dr. W. L. Abbott; original number 2349.

Geographic distribution.—Pulo Pinie, Batu Islands.

Diagnostic characters.—General coloration bright (light markings on hairs ochraceous orange to zinc orange), light and dark colors of upperparts and sides so arranged as to produce coarse speckling, dark colors of upperparts less conspicuous and less blackish than in case of Masa and Bala specimens; underparts white, a collar present in only one out of four specimens at hand.

Measurements.—Size moderate, tail rather short; head and body, 190 to 230 mm.; tail, 140 to 160; hindfoot, 42 to 43; condylobasal length of skull, 40 to 45; width of braincase, 16.5 to 17; maxillary tooththrow, 7.2 to 7.5.

Specimens examined.—Eight from Pinie Island.

Remarks.—The rats of the *rajah* group found on the three islands, Pinie, Tana Masa, Tana Bala, of the Batu group, are closely related to each other, and practically constitute a form of *Rattus lingensis* by themselves, separable into two divisions, one on Pinie, and the other confined to the other two islands.

RATTUS FREMENS MANSALARIS, new subspecies.

1903. *Mus fremens*, MILLER, Proc. U. S. Nat. Mus., vol. 26, p. 463, February 3, 1903.

Type-specimen.—No. 114583, U.S.N.M., skin and skull of adult male, collected on Pulo Mansalar, off west coast of Sumatra, March 4, 1902, by Dr. W. L. Abbott; original number, 1591.

Geographic distribution.—Mansalar Island.

Diagnostic characters.—A dull colored member of the *Rattus vociferans* group, with the general color avellaneous, replacing the cinnamon-buff of *Rattus vociferans tapanulius*;¹ skull angular with thick, heavy rostrum, as compared with *R. fremens fremens*.

Color, etc.—Upperparts and sides of head, neck, and body, and outside of legs a mixture of dull cinnamon-buff and blackish; the darker color predominating along the middle line of head and back, the two about equally mixed along the sides and outside of legs producing the general effect of avellaneous. Underparts including inside of legs, varying from whitish to cream color. Tail, dull brownish, somewhat lighter on underside at base. Eight scales to the centimeter at center, each scale subtended by three light colored hairs about one and one-half scales in length.

Skull and teeth.—Skull, in comparison with *Rattus vociferans tapanulius* and *fremens fremens*, large, angular, heavy, particularly rostrum; temporal ridge beading well marked and angle of beading at frontoparietal suture conspicuous. Teeth show no essential differences from related members of the group.

Measurements.—Type: Head and body, 250 mm.; tail, 299; hind-foot, 47; condylobasal length, 51.5; zygomatic width, 25.5; width of braincase, 20; maxillary toothrow, 10.5. Tail rather short for the group; about 300 mm. or slightly less.

Specimens examined.—Seven from Mansalar Island.

Remarks.—In spite of the close proximity of this form to *Rattus vociferans tapanulius* of the adjacent mainland it is very closely related to *Epimys fremens fremens* Miller² of Sinkep Island, in its general characteristics. It is probably a case of parallel development.

RATTUS FREMENS TUANCUS, new subspecies.

1903. *Mus fremens* MILLER, Proc. U. S. Nat. Mus., vol. 26, p. 463, February 3, 1903.

Type-specimen.—No. 114402, U.S.N.M., skin and skull of adult male, collected on Pulo Tuanku, Banjak Islands, January 26, 1902, by Dr. W. L. Abbott; original number, 1470.

Geographic distribution.—Pulos Tuanku and Bankaru, Banjak Islands.

Diagnostic characters.—A dull colored member of the *Rattus vociferans* group very similar to *R. fremens mansalaris* above, but skull slenderer, less angular, with longer, slenderer rostrum, and differing from *R. fremens fremens* in its larger size of skull and relatively shorter tail.

¹ Lyon, Proc. Biol. Soc. Wash., vol. 29, p. 209, September 22, 1916.

² Proc. Acad. Nat. Sci. Philadelphia, 1902, p. 154, March, 1902.

Color, etc.—The color of *Rattus fremens tuancus* is essentially like that of *R. fremens mansalaris*; the number of scales on tail and arrangement of hairs are essentially the same in the two forms, but in each the tail is darker than it is in *R. fremens fremens*.

Skull and teeth.—Skull is large, slender in appearance, the rostrum particularly so, and the angle on the temporal ridge less conspicuous than it is in *Rattus fremens mansalaris*.

Measurements.—Type: Head and body, 257 mm.; tail, 328; hind-foot, 47; condylobasal length, 53; zygomatic width, 26.5; width of brain-case, 19.5; maxillary toothrow, 10.5. Tail has about the same absolute length as that of *Rattus fremens fremens*, and is slightly longer than that of *R. fremens mansalaris*, being about 325 mm. instead of 300 mm.

Remarks.—The two forms just described were recognized as constituting a heterogenous group by Mr. Miller (1903a) who said of them: "This series shows variation in both size and color."

Order PRIMATES.

Family LASIOPYGIDAE.

PITHECUS MANSALARIS, new species.

1903. *Macacus "cynomolgus"* MILLER, Proc. U. S. Nat. Mus., vol. 26, p. 476, February 3, 1903.

Type-specimen.—No. 114560, U.S.N.M., skin and skull of adult male, collected on Mansalar Island, March 10, 1902, by Dr. W. L. Abbott; original number 1639.

Geographic distribution.—Mansalar Island.

Diagnostic characters.—A geographic form of *Pithecus fascicularis*, of the same general plan of coloration except that the upper part of head, neck, and body are of a general bright amber brown color and upperpart of tail is slightly darker.

Skull and teeth.—These show no distinguishing features.

Measurements.—Type: Head and body, 440 mm.; tail, 500; hind-foot, 125; condylobasal length, 88.5; braincase width, 55; postorbital constriction, 39.5; maxillary toothrow, 34.2; weight, 11½ pounds (5.1 kilos).

Specimens examined.—Three from Mansalar Island, two skins with skulls and one skull without skin. One of the skins is without tail; "Tail shot off." W. L. A.

Remarks.—The bright coloration of *Pithecus mansalaris* is quite striking when compared with the specimens from Tapanuli Bay, only a few miles distant.

PITHECUS FUSCUS LASIAE, new subspecies.

1903. *Macacus fuscus* MILLER, Proc. U. S. Nat. Mus., vol. 26, p. 476, February 3, 1903. Type-locality: Simalur.

Type-specimen.—No. 114248, U.S.N.M., skin and skull of adult male, collected on Pulo Lasia, January 5, 1902, by Dr. W. L. Abbott; original number, 1398.

Geographic distribution.—Pulo Lasia.

Diagnostic characters.—Essentially like the typical *Pithecus fuscus*, except that black of back of neck and upper part of back is slightly more conspicuous; tail decidedly longer than head and body and more than 500 mm. in length.

Skull and teeth.—These show no characters to distinguish the Lasia race from that inhabiting the larger island.

Measurements.—Type: Head and body, 470 mm.; tail, 555; hind-foot, 135; condylobasal length, 96; width of braincase, 58; postorbital constriction, 39; maxillary toothrow, 40; weight, 14 pounds (6.3 kilos).

Specimens examined.—The type and an immature male.

Remarks.—*Pithecus fuscus lasiae* is a slightly modified form of *P. fuscus*. The material on which it is based is not entirely satisfactory as to numbers, but the long tails of the two specimens are not equalled by any of the eleven from Pulo Simalur. This peculiarity of the Lasia specimens was pointed out by Miller in 1903.

Order ARTIODACTYLA.

Family SUIDAE.

SUS BABI TUANCUS, new subspecies.

1903. *Sus vittatus*, MILLER, Proc. U. S. Nat. Mus., vol. 26, p. 446, February 3, 1903.

1906. *Sus babi* MILLER, Proc. U. S. Nat. Mus., vol. 30, p. 752, June 13, 1906.

Type-specimen.—No. 114415, U.S.N.M., skin and skull of adult female, collected on Tuanku Island, January 9, 1902, by Dr. W. L. Abbott; original number 1412.

Geographic distribution.—Pulo Tuanku, Banjak Islands.

Diagnostic characters.—Distinguished by its short nasals, 127 mm., short premaxillary bones, 93 mm. (less than 100) and long nutrient artery groove in frontal bone, 35 to 40 mm.; color of type, dark—that is, blackish—but with a fair amount of buffy grizzling, especially along sides, neck, and rump; a second specimen is conspicuously grizzled throughout.

Measurements.—Type: condylobasal length, 268 mm.; tip of nasals to lambdoid notch, 283; greatest length of nasals, 127; width of nasals at base, 31; greatest length of premaxillary, 93; external nutrient groove or frontal bone (chord) 40; upper premolar-molar series, 101; second upper molar, 18 by 17; third upper molar 28 by 19.

Specimens examined.—Two, skins and skulls from Tuanku Island.

Remarks.—Geographically this pig ought to be closely related to *Sus vittatus*, but its general appearance and rather wide rostrum show its affinities with *Sus babi*. All the pigs of this group are rather closely related, but the forms from Babi, Tuanku, and Engano seem to form a group in contradistinction to the others.

SUS BABI ENGANUS, new subspecies.

1906 ? *Sus babi* MILLER, Proc. U. S. Nat. Mus., vol. 30, pp. 752, June 13, 1906, and 820, June 4, 1906.

Type-specimen.—No. 140959, U.S.N.M., skull of very old female, collected on Engano Island November 30, 1904, by Dr. W. L. Abbott; original number 3814.

Geographic distribution.—Engano Island.

Diagnostic characters.—Intermediate in characters between *Sus babi babi* and *S. babi tuancus*; nasals long, 140 mm.; and premaxillary long, 115 mm., as in the Babi form; nutrient artery groove on frontal long, 39 mm., as in the Tuanku pig; color of type unknown; of a young male, almost entirely blackish.

Measurements.—Type: Condylbasal length, 267 mm.; tip of nasals to lambdoid notch, 293; greatest length of nasals 140; width of nasals at base, 33; greatest length of premaxilla, 115; external nutrient groove on frontal bone (chord), 39; premolar-molar series, 99; second upper molar, 16 by 16; third upper molar, 29 by 19.

Specimens examined.—Skull of an old female, and skin and skull of a young male from Engano Island.

Remarks.—The status of this pig is very unsatisfactory. In 1906, Mr. Miller was not satisfied to call it *Sus babi* without a query. It is unlike any other pig on the Barussan Islands or west coast of Sumatra. It seems to be closer to *Sus babi babi* than to *S. b. tuancus*. Whatever the origin of the Engano pig, it is clearly not the same as the other Barussan pigs and it seems more satisfactory to describe it as a new form than to try to place it with some other. In his field notes Doctor Abbott writes of the Engano pig: "Pigs are very common in Engano; they are never kept tame. They are said to be descended from some pigs which swam ashore from stranded ship. This was only 25 (?) years ago. Previously the natives said none existed." I do not wish to discredit the natives' story of the Engano pigs, but there is no zoologic and geographic reason why pigs should not occur as native animals on Engano as well as on the Nicobars, Simalur, and Babi. It is not unlikely that the pigs reached all these outlying islands by human agency. It would seem incredible that they should be the only large animal on so many small islands unless brought by man. Doctor Abbott thinks the natives may have had the stranded-ship story handed down from generation to generation and that the years refer to the observation of the first generation.

Family TRAGULIDAE.

TRAGULUS NAPU NIASIS, new subspecies.

Type-specimen.—No. 141171, U.S.N.M., skin and skull of adult male (molar teeth much worn) collected at Kwala Mojeia, Nias Island, March 4, 1905, by Dr. W. L. Abbott; original number 3979.

Geographic distribution.—Nias Island.

Diagnostic characters.—A form of *Tragulus napu* distinguished by its slightly smaller size, lighter weight, and distinctly shorter hind foot.

Color.—The color of *Tragulus napu niasis* shows no differences from that of *T. napu napu* of Sumatra.

Skull and teeth.—These show no essential differences from those of the typical subspecies; they perhaps average slightly smaller.

Measurements.—Type: Head and body, 515 mm.; tail, 75; hind foot 137; condylobasal length, 101; zygomatic width, 51; width of brain case, 34; premolar-molar series, 35; weight 7½ pounds (3.3 kilos). The greatest weight of *Tragulus napu niasis* is 8 pounds (3.6 kilos) as contrasted with 9½ pounds (4.2 kilos) of *T. napu napu*. The hind foot of adults varies from 135 to 142 mm. in the Nias form, while in the Sumatran animal it ranges from 145 to 152 mm.

Specimens examined.—Eight, all from Nias.

Remarks.—No specimens of *Tragulus* were collected in Nias by Modigliani, and none were taken by Doctor Abbott on his first visit to the island in 1903. In his notes on the second voyage to Nias in 1905 with reference to *Tragulus* Doctor Abbott says: "The *napu* were mostly caught by a native living at Batuto near the Kwala Mojeia. They were all caught by driving into the water (creeks) with dogs. The one from Samasama (No. 141170) was caught in a 'lapun.' No kanchil exists."

TRAGULUS PINIUS, new species.

1903. *Tragulus russulus* MILLER, Smiths. Misc. Coll., vol. 45, p. 3, November 6, 1903. (Specimens from Pinie.)

Type-specimen.—No. 121837, U.S.N.M., skin and skull of subadult male (molar teeth slightly worn, last deciduous premolar in place), collected on Pulo Pinie, March 3, 1903, by Dr. W. L. Abbott; original number 2362.

Geographic distribution.—Pulo Pinie.

Diagnostic characters.—A fairly large member of the *kanchil* group distinguished among the Barussan kanchils by a general buff-yellow or antimony coloration, with only a moderate admixture of blackish brown.

Color.—Upperparts and sides of head, neck, and body, a coarse mixture of buff-yellow or antimony to almost dull ochraceous orange

and blackish or brownish black; along middle line of back the two colors about equally mixed, for a short narrow space on top of neck the blackish color exists almost alone and gradually blends in with the back posteriorly, laterally it is sharply separated from the nearly pure ochraceous orange of sides of neck; on sides of body the light buffy colors predominate; outside of legs rather darker than dull ochraceous orange. Underparts and narrow stripe on innerside of legs white, belly being suffused along middle line with ochraceous buff; collar ochraceous buff, and V similar but slightly admixed with brownish.

Skull and teeth.—These show no special peculiarities.

Measurements.—Type: Head and body 460 mm.; tail, 70; hind-foot, 125; condylobasal length, 90.7; zygomatic width, 42.5; width of braincase, 31.5; premolar-molar series, 36.3; weight, 4½ pounds (2 kilos.)

Specimens examined.—Two, from Pinie.

Remarks.—*Tragulus pinius* appears to be a well marked species. Its peculiarities were pointed out by Mr. Miller in 1903. Both of the specimens were labeled by him "*T. russulus*!". In color it is like *T. brevipes*, but is larger, with less of a nape stripe. It appears to be a much lightened form of *T. russulus*, but intergrading specimens are lacking.

TRAGULUS RUSSULUS MASAE, new subspecies.

Type-specimen.—No. 121813, U.S.N.M., skin and skull of adult female, molar teeth moderately worn, collected on Tana Masa Island, February 18, 1903, by Dr. W. L. Abbott; original number 2306.

Geographic distribution.—Tana Masa Island.

Diagnostic characters.—A very brightly colored race of *Tragulus russulus* with almost a lack of nape stripe, somewhat heavier, 6½ pounds (2.8 kilos); slightly longer toothrow.

Color.—Upperparts, sides of head, neck and body, and outside of legs in general, xanthine orange, slightly admixed with blackish on upperparts, blackish element being concentrated to produce a slight nape patch. Underparts in general and stripe on innerside of legs, white with some light xanthine orange suffusions on belly; collar and throat V, xanthine orange, slightly lined with blackish.

Skull and teeth.—Aside from a longer toothrow these show no peculiarities.

Measurements.—Type: Head and body, 500 mm.; tail, 75; hind-foot, 122; condylobasal length, 92.8; zygomatic width, 45; width of braincase, 32.5; premolar-molar series, 36.2; weight, 6½ pounds (2.8 kilos). The single specimen from Tana Masa is larger and heavier than any from Tana Bala.

Specimens examined.—One, the type.

Remarks.—*Tragulus russulus masae* is a slightly differentiated form and shows an extreme development in color of kanchils found on Tana Bala, as represented by the type of typical *T. russulus*. None of the six specimens from Tana Bala are so lacking in a nape patch as is *T. r. masae*.

LIST OF ISLANDS VISITED BY DOCTOR ABBOTT, 1901 TO 1905, AND SPECIES OF MAMMALS COLLECTED ON EACH.

SIMALUR ISLAND.

November 18 to December 19, 1901, October 23 to 28, 1902.

Paradoxurus hermaphroditus parvus Miller (1913).

Rattus simalurensis simalurensis Miller (1903a).

Rattus concolor surdus Miller (1903a).

Pithecius fuscus fuscus Miller (1903a).

Sus minus Miller (1906c).

SIUMAT ISLAND, EAST OF SIMALUR.

December 27, 1901, to January 1, 1902.

Megaderma siumatis Lyon (1916).

PULO LASIA, SOUTH OF SIMALUR.

January 4 to 7, 1902.

Megaderma lasiae Lyon (1916).

Rattus simalurensis lasiae Lyon (1916).

Pithecius fuscus lasiae Lyon (1916).

PULO BABI, SOUTH OF SIMALUR.

January 8, 9, and 14, 1902.

Cynopterus babi Lyon (1916).

Emballonura monticola Temminck.

Megaderma lasiae Lyon (1916).

Rattus simalurensis babi Lyon (1916).

Sus babi babi Miller (1906c).

PULO BANKARU, BANJAK GROUP.

January 16 to 21, 1902.

Sciurus mansularis bancarus Miller (1903a).

Sciurus pretiosus Miller (1903a).

Rattus valens (Miller) (1913).

Rattus kingensis banacus Lyon (1916).

Tragulus brevipes Miller (1903a).

PULO TUANKU, BANJAK GROUP.

January 23 to February 6, 1902.

Tana tana tuancus Lyon (1913).

Galeopterus tuancus (Miller) (1903a).

Sciurus ubericolor Miller (1903a).

Rhinosciurus incultus Lyon (1916).
Ratufa palkata laenata Miller (1903a).
Ratufa femoralis Miller (1903a).
Rattus potens (Miller) (1913).
Rattus batus (Miller) (1911).
Rattus lingensis antucus Lyon (1916).
Rattus fremens tuanacus Lyon (1916).
Pithecius agnatus Elliot (1910).
Sus babi tuancus Lyon (1916).
Tragulus russeus Miller (1903a).

MANSALAR ISLAND.

March 2 to 14, 1902.

Sciurus mansalaris mansalaris Miller (1903a).
Sciurus saturatus Miller (1903a).
Ratufa nigrescens Miller (1903a).
Rattus domitor (Miller) (1903a).
Rattus catellifer (Miller) (1903a).
Rattus fremens mansalaris Lyon (1916).
Pithecius mansalaris Lyon (1916).
Tragulus amoenus Miller (1903a).
Tragulus jugularis Miller (1903a).

NIAS ISLAND.

March 16-30, 1903; February to March 11, 1905.

Cynopterus major Miller (1906a).
Cynopterus princeps Miller (1906a).
Cynopterus minutus Miller (1906a).
Pteropus niadicus Miller (1906a).
Macroglossus minimus minimus (E. Geoffroy) (Andersen, 1912).
Emballonura monticola Temminck.
Megaderma niasense Lyon (1916).
Rhinolophus trifolius niasensis Andersen (1906).
Rhinolophus circe Andersen (1906).
Hipposideros larvatus.
Hipposideros sp.
Hipposideros sp.
Myotis niasensis Lyon (1916).
Arctictis niasensis Lyon (1916).
Rattus maerens (Miller) (1911).
Rattus concolor concolor (Blyth).
Rattus batus (Miller) (1911).
Rattus barussamus (Miller) (1911).
Chiropodomys niadis Miller (1903b).
Manis javanica Desmarest.
Pithecius phaeura (Miller) (1903b).
Sus niadensis Miller (1906c).
Tragulus napu niasis Lyon (1916).
Cervulus moschatus (Blaineville).
Rusa equina (Cuvier).

TANA BALA, BATU ISLANDS.

February 2 to 14, 1903.

- Tupaia tephrra* Miller (1903b).
Tana cervicalis cervicalis (Miller) (1903b).
Galeopterus saturatus (Miller) (1903b).
Hipposideros sp.
Sciurus balae Miller (1903b).
Sciurus mansularis batus Lyon (1916).
Sciurus ictericus Miller (1903b).
Lariscus rostratus Miller (1903b).
Ratufa palliata batuana Lyon (1916).
Ratufa balae balae Miller (1903b).
Petaurista batuana batuana Miller (1903b).
Rattus balmasus Lyon (1916).
Rattus batus (Miller) (1911).
Rattus lingensis mabalus Lyon (1916).
Rattus masae balae (Miller) (1903b).
Pithecius fascicularis (Raffles).
Pygathrix batuana (Miller) (1903b).
Tragulus batuanus Miller (1903b).
Tragulus russulus russulus Miller (1903b).

TANA MASA, BATU ISLANDS.

February 17 to 23, 1903.

- Tana cervicalis masae* Lyon (1913).
Emballonura monticola Temminck.
Sciurus mansularis batus Lyon (1916).
Sciurus ictericus Miller (1903b).
Ratufa palliata batuana Lyon (1916).
Ratufa balae masae Miller (1903b).
Petaurista batuana batuana Miller (1903b).
Rattus balmasus Lyon (1916).
Rattus batus (Miller) (1911).
Rattus lingensis mabalus Lyon (1916).
Rattus masae masae (Miller) (1903b).
Pithecius fascicularis (Raffles).
Pygathrix batuana (Miller) (1903b).
Tragulus batuanus Miller (1903b).
Tragulus russulus masae Lyon (1916).

PULO PINIE, BATU ISLANDS.

February 28 to March 8, 1903.

- Philocercus lowii continentis* Thomas (Lyon, 1913).
Cynopterus brachyotis (Müller) (Andersen, 1912).
Sciurus piniensis Miller (1903b).
Sciurus ictericus Miller (1903b).
Ratufa balae piniensis Miller (1903b).
Petaurista batuana batuana Miller (1903b).
Rattus pinatus Lyon (1916).
Rattus batus (Miller) (1911).
Rattus lingensis pinacus Lyon (1916).
Pygathrix batuana (Miller) (1903b).
Tragulus pinius Lyon (1916).
Galeopterus saturatus (Miller) (1903b).

SIBERUT ISLAND.

January 22, 1903.

Emballonura monticola Temminck.

NORTH AND SOUTH PAGI ISLANDS.

November 11, 1902, to January 14, 1903.

Tupaia chrysogaster Miller (1903b).
Cynopterus brachyotis (Müller) (Andersen, 1912).
Pteropus vampyrus malaccensis Andersen (1912).
Myotis abbotti Lyon (1916).
Paradoxurus lignicolor Miller (1903b).
Hemigalus minor Miller (1903b).
Sciurus pumilus Miller (1903b).
Sciurus atratus Miller (1903b).
Lariscus obscurus Miller (1903b).
Sciuropterus maerens Miller (1903b).
Rattus lugens Miller (1903b).
Rattus neglectus, subspecies.
Rattus pagensis (Miller) (1903b).
Rattus soccatus (Miller) (1903b).
Manis javanica Desmarest.
Pithecius pagensis (Miller) (1903b).
Pygathrix potenziani (Bonaparte) (Thomas, 1894b).
Simias concolor Miller (1903b).
Symphalangus klossi Miller (1903b).
Rusa equina (Cuvier).

ENGANO ISLAND.

November and December, 1904.

Pteropus modigliani Thomas (1894a).
Pteropus hypomelanus enganus Miller (1906b).
Rhinolophus calypso Andersen (1905).
Hipposideros, species.
Pipistrellus macrotis Temminck.¹
Kerivoula engana Miller (1906b).
Paradoxurus hermaphroditus enganus Lyon (1916).
Rattus enganus Miller (1906b).
Sus babi enganus Lyon, 1916).

¹ Mr. Oldfield Thomas (Ann. Mag. Nat. Hist., ser. 8, vol. 15, p. 229, February, 1915) has lately suggested that *Pipistrellus curtatus* is perhaps identical with *P. tralatitius*. This is not the case, however. In the United States National Museum there are examples of *P. tralatitius* from Java, *P. imbricatus* from Java, *P. kitcheneri* from Borneo, as well as the unique type of *P. curtatus*. The three latter species seem to constitute a group by themselves, apart from *P. tralatitius*, distinguished by their broad short rostrums. *P. curtatus* is the smallest of the three. It is proportionally smaller than *P. imbricatus*, than *P. imbricatus* is smaller than *P. kitcheneri*. Owing to its shortened rostrum it is even smaller than *P. tralatitius*. *Pipistrellus curtatus*, however, does not appear to be distinguished from a series of *Pipistrellus* from Taruman Bay, Sumatra, and for the Sumatran bat Thomas seems to have correctly shown that Temminck's name *Vespertilio macrotis* is available (Monographies de Mammalogie, vol. 2, p. 218, 1835-1841).

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1913. ———.

Treeshrews: An account of the mammalian family *Tupaia*idae.

Proc. U. S. Nat. Mus., vol. 45, pp. 1-188, November 29, 1913.

1916. ———.

Mammals collected by Dr. W. L. Abbott on the chain of islands lying off the western coast of Sumatra, with descriptions of 28 new species and subspecies.

Proc. U. S. Nat. Mus., vol. 52, pp. 437-462, December 30, 1916. The present paper.

1903a. MILLER, GERRIT S. JR.

Mammals collected by Dr. W. L. Abbott on the coast and islands of northwest Sumatra.

Proc. U. S. Nat. Mus., vol. 26, pp. 437-484, February 3, 1903.

1903b. ———.

Seventy new Malayan mammals.

Smiths. Misc. Coll., vol. 45, No. 1420, pp. 1-73, November 6, 1903.

1906a. ———.

Seven new Malayan bats.

Proc. Biol. Soc. Wash., vol. 19, pp. 61-66, May 1, 1906.

1906b. ———.

The mammals of Engano Island, west Sumatra.

Proc. U. S. Nat. Mus., vol. 30, pp. 819-825, June 4, 1906.

1906c. ———.

Notes on Malayan pigs.

Proc. U. S. Nat. Mus., vol. 30, pp. 737-758, June 13, 1906.

1911. ———.

Descriptions of six new mammals from the Malay Archipelago.

Proc. Biol. Soc. Wash., vol. 24, pp. 25-28, February 24, 1911.

1913. ———.

Fifty-one new Malayan mammals.

Smiths. Misc. Coll., vol. 61, No. 21, pp. 1-30, December 29, 1913.

1889. MODIGLIANI, E.

Appunti intorno ai mammiferi dell' isola Nias.

Ann. Mus. Civ. Stor. Nat., ser. 2, vol. 7, pp. 238-245, 1889.

1894a. THOMAS, OLDFIELD.

On some mammals from Engano Island, west of Sumatra.

Ann. Mus. Civ. Stor. Nat., ser. 2, vol. 14, pp. 105-110, 1894.

1894b. ———.

On some mammals collected by Dr. E. Modigliani in Sipora, Mentawai Islands.

Ann. Mus. Civ. Stor. Nat. Genova, ser. 2, vol. 14, pp. 660-672, 1894.

NEW SPECIES OF FOSSIL BEETLES FROM FLORISSANT, COLORADO.

By H. F. WICKHAM,

Professor of Entomology in the State University of Iowa, Iowa City.

A recent sending of fossil Coleoptera from Florissant contains several species not hitherto described, and in pursuance of the plan of studying all available forms from these beds, I am submitting descriptions and figures herewith. With the exception of one specimen, *Brachyspathus curiosus*, belonging to the University of Colorado, all the types are the property of the United States National Museum. One of them, *Spondylis tertiaris*, represents a family not before recognized in the Florissant shales. Some of the others are of considerable interest and importance, as will be seen by a perusal of the list.

CARABIDAE.

Platynus insculptipennis, new species.
Cratacanthus florissantensis, new species.
Harpalus ulomaeformis, new species.
Harpalus redivivus, new species.

COCCINELLIDAE.

Anatis resurgens, new species.

BUPRESTIDAE.

Brachyspathus curiosus, new species.

LAMPYRIDAE.

Podabrus cupesoides, new species.

MALACHIIDAE.

Malachius immurus, new name.

PTINIDAE.

Vrilletta monstrosa, new species.

SPONDYLIDAE.

Spondylis tertiaris, new species.

CERAMBYCIDAE.

Callidium grandaeum, new species.

BRUCHIDAE.

Bruchus antaeus, new species.

OTIORHYNCHIDAE.

Pandelateinus nudus, new species.

CURCULIONIDAE.

Tychius ferox, new species.
Baris primalis, new species.

Genus PLATYNUS Bonell.

PLATYNUS INSCULPTIPENNIS, new species.

Plate 37, fig. 1.

Form fairly stout for this genus. Head, as preserved, about as long as the prothorax, showing no sculpture other than a minute

roughening, which is brought out only under high magnifying power. Eyes small. Antennae slender, distal segments lost, second joint much shorter than the third. Prothorax approximately one-third broader than long, sides regularly arcuate or nearly so, angles not long nor prominent, surface practically smooth, like the head. Elytra about $3\frac{1}{2}$ times as long as the prothoracic median line, apparently very finely and faintly striate, but of this I can not be sure. Legs of moderate size, showing no details of any importance. Length, from front of head to abdominal apex, 10.25 mm.

Type.—Cat. No. 63441, U.S.N.M.

The single specimen, with counterpart, looks like *Platynus*, but the almost complete lack of sculpture is suspicious. However, this may be due partly to the state of preservation, which is only fair. It is not at all like *P. tartareus* from these shales.

Genus CRATACANTHUS Dejean.

CRATACANTHUS FLORISSANTENSIS, new species.

Plate 37, fig. 2.

Form rather stout, as in the recent *C. dubius*. Head large, as in that species, with prominent jaws. Antennae not well preserved, but showing that they reached to, or somewhat beyond, the prothoracic hind angles. Prothorax narrowed behind, broader in front of the middle, sides arcuately narrowing again to the front angles which are a little prominent but hardly acute. Elytra displaying no sculpture aside from feeble traces of striae showing through. Legs rather short and stout. Length, from apex of mandibles to that of abdomen, 9 mm.; of elytron, 5 mm.

Type.—Cat. No. 63442, U.S.N.M.

Described from one specimen, showing the under side. The resemblance to our modern North American *C. dubius* is quite marked, but apparently the fossil has a somewhat shorter prothorax and longer antennae. It is not like any of Scudder's described fossil Carabidae, the large head being definitive.

Genus HARPALUS Latreille.

HARPALUS ULOMAEFORMIS, new species.

Plate 37, fig. 3.

Form quite elongate, parallel sided. Head of moderate size, mandibles not abnormally developed. Antennae not preserved, except a small part of the base of one which is too poor for description. Prothorax much narrower anteriorly, arcuate in regular curve from the base which is the widest part. Elytra showing faint signs of punctured striae which have set through so as to appear on the under-side. Abdomen with practically straight sides to near the apex.

Legs in poor preservation, rather short. Length, from apex of mandibles to abdominal tip, 10.25 mm.; of elytron, 6 mm.

Type.—Cat. No. 63443, U.S.N.M.

Described from one specimen. Evidently this insect is not identical with any of those described by Scudder and it differs in prothoracic outline from any of the Florissant fossil Carabidae with which it might be compared. At first sight, it looks like a Tenebrionid of the *Uloma* type, but the prothoracic hypomera are those of a Carabid. The aspect, in this family, is decidedly harpaloid, whence the generic reference which is to be given a broad interpretation.

HARPALUS REDIVIVUS, new species.

Plate 39, fig. 1.

Form stout, similar to that of the recent *H. oblitus*. Head short and broad, rugose laterally beneath, the jaws not prominent. Antennae obscure. Prothorax distorted but evidently rather short, punctured beneath at sides, prosternum nearly smooth. One elytron is extended from the body and twisted so as to expose the upper surface; this shows the striae to have been moderately deep with distinct transverse punctures closely placed, the interstitial spaces convex, almost smooth. The other, overlapped by the abdomen, exhibits only the general courses of the striae. Legs of moderate size. Length of elytron, 10.85 mm.; of head and prothorax, 5 mm.

Type.—Cat. No. 63444, U.S.N.M.

The single specimen indicates a species approached in the Florissant fossil fauna only by *Harpalus maceratus* which is larger and has a strongly projecting muzzle. It can not possibly be confused with any of Scudder's Carabidae.

Genus ANATIS Mulsant.

ANATIS RESURGENS, new species.

Plate 38, fig. 1.

Preserved in ventral view. Antennae wanting. Form suborbicular but with the edges, as preserved, interrupted at the junction of the prothorax and elytra. Head moderately large. Prothorax subcrescentic in outline, the side margins not in good condition, the base regularly arcuate, apex deeply emarginate, with a rounded lobe at middle. Elytra, taken conjointly, of nearly circular outline apparently with a wide side margin. On this margin are shown one or two indistinct marks which appear to represent the similar creases in corresponding position on the underside of the elytra in the recent North American *Anatis 15-punctata*. Length, 8 mm.; width, across elytra, 5.75 mm.

Type.—Cat. No. 63445, U.S.N.M.

65008°—Proc.N.M.vol.52—17—30

Described from one specimen. Compared with other fossil Florissant Coccinellidae, this is the largest, but is closely approached in size by *Coccinella sodoma*. The prothorax is of different outline in the two and I think they are distinct. The reference to *Anatis* is, of course, provisional and is based more upon size than anything else.

BRACHYSPATHUS, new genus.

This name is proposed for a fossil Buprestid which does not seem to fall into any of the modern genera known to me. The body is elongate, more or less elateriform, not at all cuneate, antennae short, only slightly serrate. The most essential character is the form of the prosternal tip, which is expanded into a long, stalked lobe, shaped something like a spatula, and emarginate at apex.

The type is *Brachyspathus curiosus*, described below.

BRACHYSPATHUS CURIOSUS, new species.

Plate 38, figs. 2, 3.

Preserved in ventral view. Form elongate, subparallel. Head rather small, frontal region strongly punctured, the punctures as close together as possible without becoming confluent. The sculpture evidently shows through, since farther back, where the integument is thicker, none is distinguishable. Antennae not well preserved, but what remains of one of them indicates that the basal joint is large, the second and third much smaller, subequal, together about one-third longer than the fourth, which is nearly of the same size as the fifth, sixth, seventh, or eighth, none of them strongly serrate. Prothorax with rather feebly arcuate sides, base not much narrowed, surface strongly, moderately coarsely and very closely but not confluent punctured, less deeply on the flanks, each puncture rounded and with a little mark as of a scale or hair at the bottom. Prosternal sutures nearly straight, not deeply excavated, lobe of anterior margin short, subtruncate, posterior tip of prosternum spatulate, notched apically and margined all around, strongly punctured like the body of the sternum. Meso and metasternal areas punctured similarly to the prosternum but somewhat more finely, becoming much more so in front of the hind coxal plates, which are also strongly punctate, broad over the insertion of the thighs, narrowing quite suddenly externally, and obscurely toothed on the hind margin. Abdomen much more finely punctured than the prothorax, sparsely at middle, moderately closely externally, scantily hairy. Legs rather short. Coxae all punctate, femora less strongly, tibiae still more finely. The elytra are evidently quite deeply striate, the grooves showing through. Length, total, 13.50 mm.

Type.—In the Museum of the University of Colorado, collected at Florissant, in 1906, by Prof. Cockerell's party and bearing his number 184. It came from Station 14, a most productive locality.

Described from one specimen. The most striking superficial character of the insect is its rough punctuation, which extends even to the antennal joints. The peculiar structural feature is the spatulate emarginate prosternal process, which has been hard to match on any Coleoptera known to me. An approach to it is seen in the Javanese *Belionota scutellaris*, where the process is very similarly broadened apically, but, instead of being simply emarginate, the tip in that species is divided into three teeth or lobes. In other respects the fossil is not at all close to the species cited, being far less specialized in antennal, coxal, and tarsal structure.

Genus PODABRUS Westwood.

PODABRUS CUPESOIDES, new species.

Plate 37, fig. 4.

Form narrow, elongate, parallel. Head distinctly narrowed behind. Antennae long and slender, reaching nearly to the elytral apices, the joints very little serrate. Prothorax about as long as the head but considerably broader, sides obscurely preserved but apparently rounding. Elytra, conjointly, a little less than two and one-half times as long as broad, their apices rounding. Abdomen, as preserved, extending well beyond the elytral tips but probably distended as indicated by the broad transverse bands which show location of the sutures. Length, to tip of abdomen, 8 mm.; to tip of elytra, 7 mm.; of elytron, 5.35 mm.; width, across broadest part of elytra, 2.30 mm.

Type.—Cat. No. 63446, U.S.N.M.

The type of this species bears a notable resemblance to a small *Cupes*, partly because of the way in which it is displayed upon the stone. The small size and long antennae will separate it from any other Florissant fossil *Podabrus*, into which genus it seems to go by the posterior constriction of the head and the truncate prothoracic apex. The sculpture is of the finely scabrous type common among the recent species. With the type, I have associated under the same name a considerable number of examples belonging to various other collections, especially those of the Museum of Comparative Zoology and the University of Colorado. It is possible that more than one species is concerned, but I can find no definite basis of separation. The texture of these beetles is so soft that they do not, as a rule, show up well as fossils and characters used in discrimination of recent forms, such as those founded upon structures of claws and maxillary palpi, are never visible upon the stones.

Genus *MALACHIUS* Fabricius.*MALACHIUS IMMURUS*, new name.

Unfortunately the name *pristinus*, under which I described a fossil *Malachius* from Florissant,¹ had previously been used by Fall for a recent Californian species. Since he has kindly called my attention to the oversight, I wish to substitute for the fossil the name proposed above.

Genus *VRILLETTA* LeConte.*VRILLETTA MONSTROSA*, new species.

Plate 37, fig. 5.

Form moderately elongate. Head deflexed, but not very strongly, surface extremely minutely and rather sparsely granulate on the front and vertex, but closely, finely and confusedly punctured on the sides near the thoracic front margin. Eye, as preserved, rather quadrate in outline, in life probably nearly circular. Antennae lost except a few disconnected joints which, in general, are scarcely serrate but the terminal ones appear to be larger. Prothorax about equal in height and breadth, back irregularly arched, surface granulate like the head but somewhat more coarsely and sparsely. Elytra approximately two and one-third times the prothoracic length, epipleural lobe distinct, set off from the remainder of the elytron by a fine ridge or crease, striae of small, rounded, moderately deep punctures separated in each series by about their own diameters or a little less, interstitial spaces broad, flat, minutely alutaceous. The tip is not well preserved, so that the lines are indistinct in that region. Under side nearly smooth. Legs short, not very stout, extremely minutely pubescent, tibiae carinate. Length, from front of pronotum to abdominal apex, 9.25 mm.

Type.—Cat. No. 63447, U.S.N.M.

One specimen, with counterpart. There is no difficulty in distinguishing this beetle from other fossil Florissant Anobiinae, the great size, in itself, serving for identification. The reference to this subfamily is made on the basis of the form of the prothorax, its relation to the head, the cephalic, thoracic, and elytral sculpture, the antennae, as far as shown, and especially upon the tarsal structure which is like that of the recent *Vrilletta murrayi* from our Pacific coast. The sculptural characters are more like those of *V. plumbea* from the same general region. The generic assignment rests upon general similarity rather than upon truly definitive features.

¹ Bull. Lab. Nat. Hist. Univ. Iowa, vol. 7, No. 8, p. 8.

Genus SPONDYLIS Fabricius.

SPONDYLIS TERTIARIUS, new species

Plate 39, figs. 2, 3.

Form fairly elongate. Head finely and closely granulate, narrower than the prothorax, genae prominent, subspinose. Mandibles rough basally, smooth distally, as in the recent North American *S. upiformis*, quite strongly prominent. Antennae short, joints transverse, those of the base and apex wanting or obscured. Prothorax much broader than long, sides nearly straight but apparently not margined, surface sculpture coarser and shallower than that of the head. Elytra not very well preserved, the surface showing scarcely any definite sculpture except traces of certain costate markings similar to those of the modern species with which it has been compared. Legs short, tibiae longitudinally carinate. Length, as preserved, from point of mandibles to elytral tip, 18.25 mm.

Type.—Cat. No. 63448, U.S.N.M.

No doubt can be held as to the family affinities of this beetle. It is evidently a Spondylid and the first representative of this family from the Florissant shales. The shape of the prothorax and carination of the tibiae point to *Parandra*, but the apparent lack of prothoracic margin, the form of the genae, the sculpture of head and pronotum (as far as preserved) and the elytral costations have led me to refer it, in preference, to *Spondylis*. When the characters are better known, it may become necessary to erect a new genus for this insect.

Genus CALLIDIUM Fabricius.

CALLIDIUM GRANDAEVUM, new species.

Plate 38, figs. 4, 5.

Form elongate, subparallel. Head not well delimited, broad, minutely roughened beneath. Antennae much shorter than the body, not reaching far beyond the abdominal base, scarcely at all serrate, first joint large, thick, second small, length and breadth about equal, third, fourth, and fifth subequal to each other, each about two and one-half times as long as the second, sixth and seventh a little shorter, eighth to eleventh much narrower and still shorter than those preceding, the tenth not so long as its neighbors. Prothorax broad, sides, as preserved, nearly straight, under surface finely transversely rugose especially along the flanks. Abdomen somewhat distinctly banded with darker. Legs short, not well shown. Length, to abdominal apex, 13.50 mm.; of antenna, from base of second joint to tip, 7.20 mm.

Type.—Cat. No. 63449, U.S.N.M.

Described from one specimen. My first impression was that this beetle belonged to the Clytini, but the antennae are not of the right structure. They are more like those of some Callidioides, notably the recent North American *Callidium aereum*, and since no generic characters show which are available for separation, I have placed the fossil in that genus. The antennal structure will serve at once to differentiate this from all similar described Florissant fossils. The detail figure shows the sudden reduction in size of the distal four joints.

Genus BRUCHUS Linnaeus.

BRUCHUS ANTAEUS, new species.

Plate 38, figs. 6, 7.

Form fairly elongate. Head small. Eyes not large nor prominent. Antennae short, thick, joints beyond the third somewhat serrate but not strongly so. Prothorax transversely subelliptical, very nearly twice as broad as long, apex narrower, sides strongly and regularly arcuate, sculpture fine, obscure. Elytra about three and one-half times the prothoracic length, delicately striate, striae hardly visibly punctured, interspaces flat, broad, minutely roughened. Legs not preserved. Length, from front of head to abdominal apex, 9.20 mm.; of elytron, 5.10 mm.

Type.—Cat No. 63450 U.S.N.M.

This single specimen is by far the largest of any of the Florissant fossil Bruchids, being more than half as long again as *B. bowditchi*, from these shales, which it resembles quite strongly in form, antennal structure and elytral sculpture. The present insect has a much more transverse prothorax and is undoubtedly distinct.

Genus PANDELETEINUS Champion.

PANDELETEINUS NUDUS, new species.

Plate 39, fig. 4.

Form stout. Head finely but pretty deeply and very closely, in part confluent punctured, with a tendency to form transverse rugae, the portion normally covered by the prothoracic front margin extremely minutely, transversely strigulose. Eye small, subcircular, nearly central in position. Beak not fully defined but evidently short and broad. Antennae concealed or lost. Prothorax much higher than long, a trifle more closely and much more rugosely punctured than the head, the individuality of the punctures largely lost in a confluence which tends to form longitudinal rugae. Elytra moderately arched, deeply striate, striae punctures strong, large, deep, and rounded, separated in each series by less than their own diameters. Interstitial spaces rather broad, convex, not punctured

but very finely alutaceous. Legs moderate or rather short. Abdomen, as far as shown along the side, nearly smooth. Length, 4.35 mm.

Type.—Cat. No. 63451, U.S.N.M.

Represented by a beautiful specimen, preserved in reverse so that the punctures above described appear as granules. The form, size, and position of the eye, structure of abdominal segments and, to a less degree, the elytral punctuation are very similar to the corresponding features in the recent *P. submetallicus* from the southwestern United States. However, the fossil is without scales and is much more closely punctate on the head and prothorax; it may be generically distinct.

Genus TYCHIUS Schönherr.

TYCHIUS FEROX, new species.

Plate 39, fig. 5.

Form fairly elongate. Head with the forehead well arched and running into the rostrum without a break, surface vaguely but closely and rather coarsely punctured. Rostrum slightly curved, moderately thick and short, punctured like the head but not striate, scrobes about straight, directed beneath the eye which is elliptical and longitudinal. Antennal scape and funiculus about equal, club oval, gradually formed. Prothorax about twice as high as long, back scarcely arched, surface closely, more or less confluent and, relatively to the size of the insect, coarsely but only fairly deeply punctured, more strongly than the head. Elytron with the margin not very well preserved and the apex apparently a little distorted, about five times as long as the prothorax, surface moderately deeply striate, the striae with distant, not very well marked, elongate punctures, interspaces visibly convex and practically smooth. Beneath, the pectus is punctate similarly to the pronotum but less strongly, abdomen nearly smooth. Legs of moderate length, the middle and hind femora very strongly dentate, their tibiae slightly bent at base. Length, as preserved, from vertex of head to elytral apex, 3.90 mm.

Type.—Cat. No. 63452, U.S.N.M.

Described from one specimen. In form and general appearance, this beetle is like the Florissant fossil *T. evolatus* and I think the two are likely enough congeneric in spite of the difference in the thighs (which are unarmed in *T. evolatus*) since the modern species of *Tychius* may have the femora either dentate or mutic.

Genus BARIS Germar.

BARIS PRIMALIS, new species.

Plate 39, figs. 6, 7.

Form moderately stout. Head small, relatively coarsely, moderately deeply and closely punctate. Rostrum nearly straight, punctate, more strongly and coarsely than the head, and striate,

length, measured from the front of the eye, about equal to that of the remainder of the head or the median line of the prothorax. Eye elliptical, rather large. Antennae wanting. Prothorax short, noticeably narrowed and quite suddenly constricted in front, punctuation coarser and deeper than that of the head, crowded but hardly confluent, each puncture with a scale mark at bottom. Elytra moderately deeply striate, the striae with large, rounded or very slightly elliptical punctures, much wider than the grooves themselves, those in each series nearly or quite touching, interstitial spaces about one-third the width of the punctures, almost smooth or, in places, finely transversely striate. Each stria puncture is somewhat crateriform, with raised edge and a central depression which may have held a scale. Sternal side pieces and pygidium punctured. Legs showing only the femora, which are of moderate length and not toothed, almost smooth. Length, excluding rostrum, 3.50 mm.

Type.—Cat. No. 63453, U.S.N.M.

Described from one specimen, with counterpart. At first I was inclined to consider it an example of *B. matura*, but that insect is smaller and is described as having punctate femora, the elytral rows of punctures separated by "scarcely more than the width of the puncta." In the diagram given by Scudder, they are separated by about half that width, but in the present species they are still closer together.

EXPLANATION OF PLATES.

PLATE 37

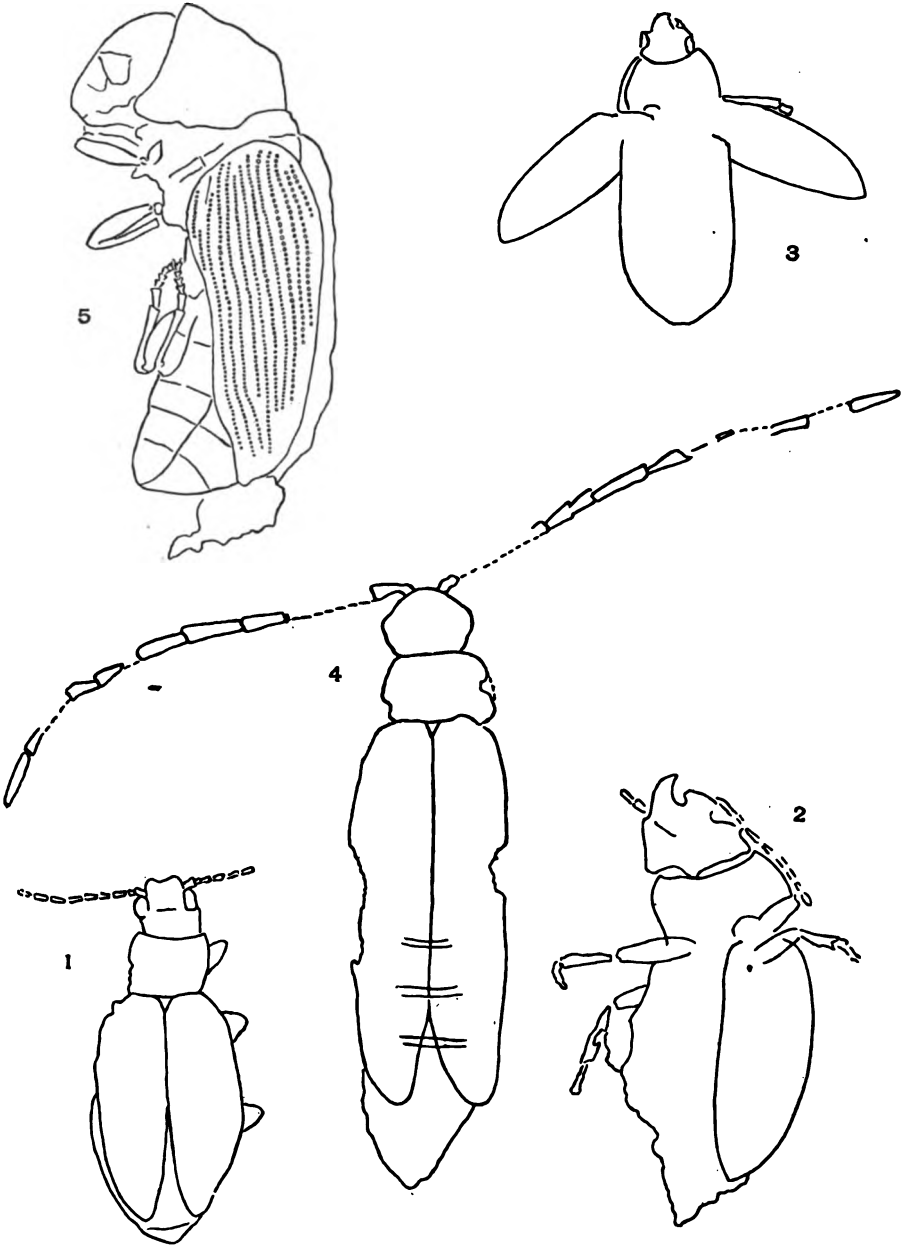
- FIG. 1. *Platynus insculptipennis*.
 2. *Cratacanthus florissantensis*.
 3. *Harpalus ulomaeformis*.
 4. *Podabrus cupesoides*.
 5. *Vrilletta monstrosa*.

PLATE 38

- FIG. 1. *Anatis resurgens*.
 2. *Brachyspathus curiosus*.
 3. *Brachyspathus curiosus*, antenna.
 4. *Callidium grandaevum*.
 5. *Callidium grandaevum*, antenna.
 6. *Bruchus antaeus*.
 7. *Bruchus antaeus*, antenna.

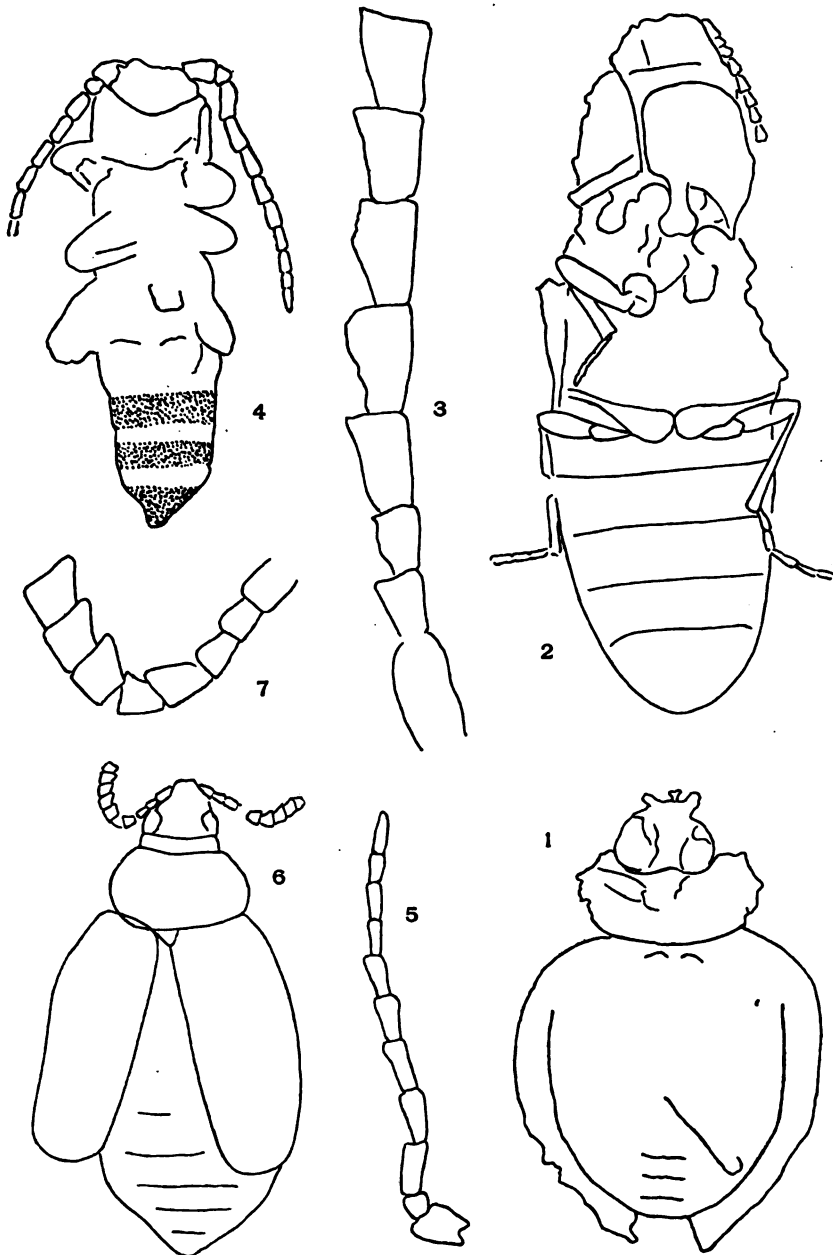
PLATE 39

- FIG. 1. *Harpalus redivivus*.
 2. *Spondylis tertiaris*.
 3. *Spondylis tertiaris*, antenna.
 4. *Pandeleiteinus nudus*.
 5. *Tychius ferox*.
 6. *Baris primalis*.
 7. *Baris primalis*, elytral punctation.



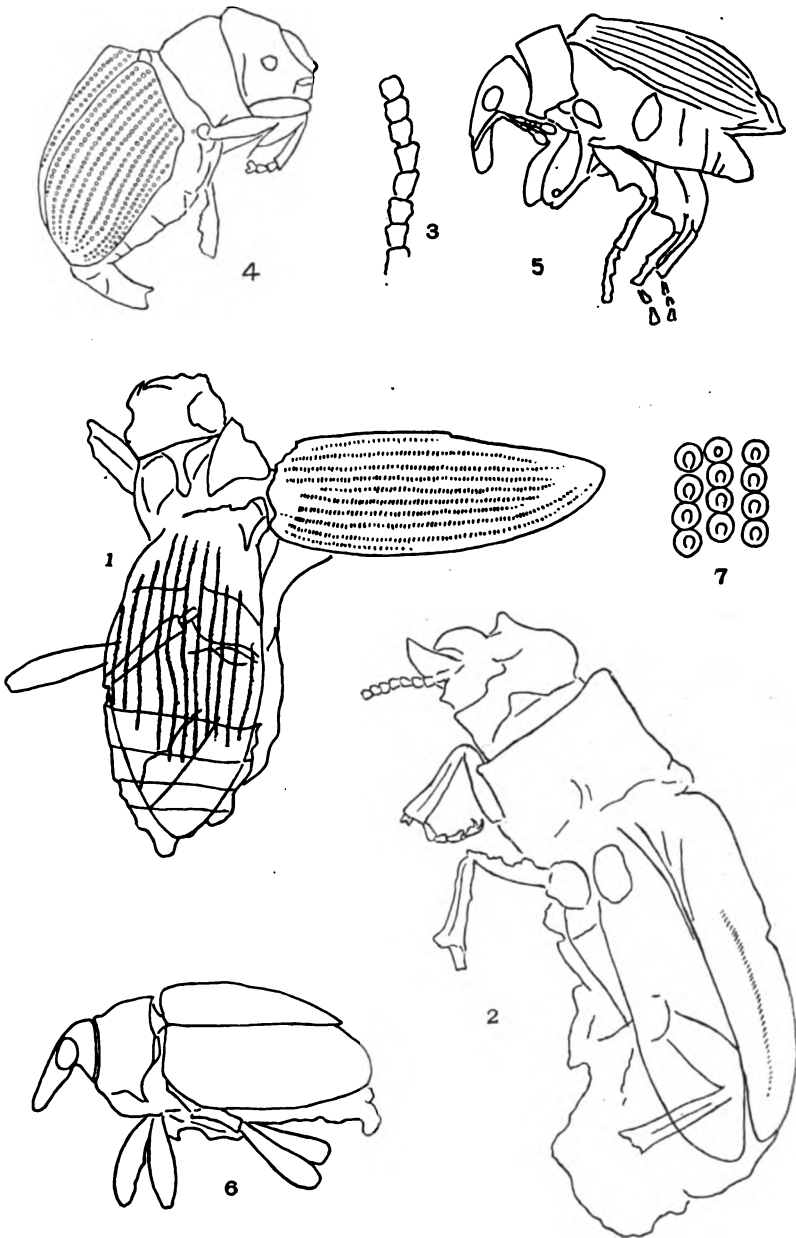
FOSSIL BEETLES FROM FLORISSANT, COLORADO.

FOR EXPLANATION OF PLATE SEE PAGE 472.



FOSSIL BEETLES FROM FLORISSANT, COLORADO.

FOR EXPLANATION OF PLATE SEE PAGE 472.



FOSSIL BEETLES FROM FLORISSANT, COLORADO.

FOR EXPLANATION OF PLATE SEE PAGE 472.

ROTATORIA OF LOS ANGELES, CALIFORNIA, AND VICINITY, WITH DESCRIPTIONS OF A NEW SPECIES.

BY FRANK J. MYERS,
Of Bethlehem, Pennsylvania.

INTRODUCTION.

The collections upon which this report is based were made by the writer from January to May, 1916. While the number of species listed is not large, the record is interesting in view of the fact that nothing is known of the Rotatoria of California; it is hoped that local students may take up the subject and extend the list.

Los Angeles is situated on a narrow, level plain intervening between the foot of the San Gabriel Mountains and the Pacific Ocean. The Los Angeles River, which passes through the city, has the usual characteristics of mountain streams; at times it is torrential and at other times its bed is practically dry.

On account of the narrowness of the level plain no large lakes exist, and as there are but two seasons, a rainy and a dry one, permanent pools and ponds are not numerous. The majority of the collections are consequently from artificial reservoirs and ornamental pools in and around the city. Through the kindness of Mr. Willi Mulholland I obtained access to the various storage reservoirs from which the water supply of the city is obtained.

Mr. H. K. Haring, of the United States National Museum, has cooperated in the determination of some of the species and added a note on *Pleurotrocha daphnicola*.

For convenience the different localities at which collections were made are referred to by numbers, as follows:

1. Permanent pool, about 1 acre in area, formed by surface drainage and overflow from a small artificial lake in East Lake Park, Los Angeles.
2. Slowly running water in Ballona Creek, a very small stream about 4 miles west of Los Angeles.
3. From service pipe of the city water supply.
4. Nigger Slough, a large body of water about 11 miles south of Los Angeles, supplied by surface drainage and melted snow from the San Gabriel Mountains.

5. Edge of a swamp north of the town of Riverside.
6. Ornamental pool on alligator farm, near East Lake Park, Los Angeles.
7. Pool formed by the Los Angeles River at a point about 14 miles south of the city, on highway to Long Beach.
8. Artificial lake in West Lake Park, Los Angeles.
9. Artificial lake in Echo Park, Los Angeles.
10. Silver Spring reservoir, eastern section of Los Angeles, near Sunset Boulevard.
11. Buena Vista reservoir, Elysian Park, Los Angeles.
12. Ornamental fountain in St. James Place, Los Angeles.

LIST OF THE SPECIES COLLECTED.

- Notommata cerberus* (Gosse), 12.
Notommata pachyura (Gosse) = *Copeus pachyurus* Gosse, 11.
Notommata tripus Ehrenberg, 10.
Taphrocampa annulosa Gosse, 1, 3, 6, 12.
Proales decipiens (Ehrenberg), 1, 6.
Pleurotrocha petromyzon Ehrenberg, 1, 3, 4, 5, 7.
Pleurotrocha daphnicola (Thompson) = *Proales daphnicola* Thompson, 4.
Eosphora najas Ehrenberg, 7. Not previously recorded from the United States.
Cephalodella catellina (Müller) = *Diglena catellina* (Müller), 1, 2, 6, 11.
Cephalodella forficula (Ehrenberg) = *Furcularia forficula* Ehrenberg, 1, 2, 3, 6, 8, 12.
Diaschiza auriculata (Müller) = *Diaschiza lacinulata* (Müller), 1, 10.
Diaschiza forficata (Ehrenberg) = *Diaschiza caeca* Gosse, 2, 6.
Diaschiza gibba (Ehrenberg), 1, 2, 3, 4, 6, 9, 11, 12.
Diaschiza globata Gosse, 6.
Diaschiza gracilis (Ehrenberg), 5, 6.
Diaschiza hoodii Gosse, 1, 5, 6, 10. Not previously recorded from the United States.
Diaschiza tenuior Gosse, 1, 6, 10, 11.
Monommata orbis (Müller) = *Furcularia longiseta* (Müller), 5.
Dicranophorus forcipatus (Müller) = *Diglena forcipata* (Müller), 1, 2, 3, 6, 11.
Encentrum felis (Müller) = *Proales felis* (Müller), 5.
Epiphanes senta (Müller) = *Hydatina senta* (Müller), 1.
Brachionus angularis Gosse, 1, 8, 9.
Brachionus angularis caudatus Barrois and Daday, 4, 8, 9.
Brachionus calyciflorus Pallas = *Brachionus pala* Ehrenberg, form *dorcas* Gosse, 1; form *amphiceros* Ehrenberg, 1, 4.
Brachionus capsuliflorus Pallas; form *bakeri* Ehrenberg, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12; form *urceolaris* Müller, 1, 5, 9.

Brachionus patulus Müller = *Brachionus militaris* Ehrenberg, 3.

Brachionus plicatilis Müller = *Brachionus mülleri* Ehrenberg, 8.

Brachionus variabilis Hempel, 2, 4.

This species, originally described from the Illinois River, at Havana, Illinois, was found very abundant. It is commensal on *Daphnia longispina* (Müller) and *Ceriodaphnia longispina* (Müller), which appears to have been unknown to Hempel; nearly every Daphnid carried about a number of these no doubt unwelcome guests, attached to the carapace. When swimming about by the action of its own cilia, *Brachionus variabilis* behaves very much as other species of this genus, but when deciding to use a Daphnid for conveyance, it attaches itself with astonishing rapidity, almost jumping upon the host. Some of the numerous varieties are illustrated on plate 40, figures 1-5. The posterior spines are found in all lengths and in individuals of all ages; no evidence was observed that would tend to confirm Hempel's suggestion: that only the young have spines, which with advancing age are absorbed. As nothing similar has ever been reported for other species of the genus, it is probably safe to dismiss it as unfounded.

Brachionus variabilis may be easily recognized by the subquadrate plate projecting over the foot opening; it is therefore evident that the animal figured by Murray in Notes on the Natural History of Bolivia and Peru (p. 26), does not belong to this species, but is no doubt one of the varieties of *Brachionus capsuliflorus* Pallas, probably the form usually called *B. urceolaris*.

Platylabus quadricornis (Ehrenberg) = *Noteus quadricornis* Ehrenberg, 3, 4.

Keratella cochlearis (Gosse) = *Anuraea cochlearis* Gosse, 1, 4, 7, 9, 12.

Keratella quadrata (Müller) = *Anuraea aculeata* Ehrenberg, normal form, 1, 3, 4, 7, 8, 10; form *valga* Ehrenberg, 1, 2, 3, 4, 7, 9.

Notholca striata (Müller), 1, 2, 3, 10.

Mytilina mucronata (Müller) = *Salpina mucronata* (Müller), 1, 6.

Mytilina ventralis (Ehrenberg) = *Salpina ventralis* Ehrenberg, normal form and form *brevispina* Ehrenberg, 11.

Euchlanis deflexa Gosse, 1, 3, 5, 6, 7, 10, 11.

Euchlanis dilatata Ehrenberg, 1, 2, 5, 6, 11.

Euchlanis lyra Hudson, 3, 10. Not previously recorded from the United States.

Euchlanis plicata Levander, 11.

As the figure accompanying the original description is somewhat diagrammatic, this apparently rare species has been illustrated on plate 41, figures 1-3. It has not previously been found in the United States.

Euchlanis pyriformis Gosse, 11.

Euchlanis triquetra Ehrenberg, 3, 5.

LECANE ASPASIA, new species.

Plate 40, figs. 6-8.

The lorica is broadly oval and nearly parallel-sided anteriorly. The anterior dorsal and ventral edges are coincident and slightly convex; at the lateral edges they are produced as two small spines. The dorsal plate is ovate and its anterior margin slightly narrower than the ventral plate; its markings are moderately prominent and fairly regular. The ventral plate is at its widest point of the same width as the dorsal plate; it has a well-marked transverse fold some distance in front of the foot. The longitudinal markings are rather faint. The posterior segment of the body is broadly rounded posteriorly and projects slightly beyond the dorsal plate. The first foot joint is nearly parallel-sided and projects over the movable joint with a minute median rounded lobe. The movable joint is broad, rounded anteriorly and sharply constricted immediately in front of the toes. The coxal plates are approximately triangular. The toes are long, slender, and parallel-sided, ending in acutely pointed claws. The body is of more than average depth.

Total length 132 μ ; length of lorica 94 μ ; width of anterior spines 63 μ , length of spines 4 μ ; length of dorsal plate 82 μ , width at widest point 73 μ , width of anterior edge 54 μ ; width of ventral plate 75 μ ; length of toes without claw 30 μ , length of claw 8 μ ; depth of body 50 μ .

Type.—Cat. No. 16832, U.S.N.M., is from a pool on alligator farm, near East Lake Park, Los Angeles.

With the large number of species belonging to this genus, differing only in minor details, comparisons are of little value; the present species has some resemblance to *Lecane arcula* Harring, but is broader and stouter, as well as being considerably larger.

Lecane curvicornis (Murray) = *Cathypna curvicornis* Murray, 7. Not previously recorded for the United States.

Lecane hornemanni (Ehrenberg) = *Cathypna hornemanni* (Ehrenberg), 11.

Lecane luna (Müller) = *Cathypna luna* (Müller), 1, 2, 6, 10, 11, 12.

Monostyla bulla Gosse, 3, 5, 7, 12.

Monostyla closterocerca Schmarda, 1, 3, 5, 12.

Monostyla cornuta (Müller), 4.

Monostyla hamata Stokes, 3.

Monostyla lunaris Ehrenberg, 4, 10.

Monostyla quadridentata Ehrenberg, 4, 10.

Monostyla stenroosi Meissner = *Monostyla bicornis* Stenroos, not of Daday. 3, 5. Not previously recorded for the United States.

Lepadella acuminata (Ehrenberg), 1, 11.

Lepadella patella (Müller), 1, 3, 5, 6, 7.

Lepadella rhomboides (Gosse), 1, 3.

- Lepadella triptera* Ehrenberg, 6.
Colurella obtusa (Gosse), 1, 4, 5, 7, 9, 12.
Colurella uncinata (Müller), 3.
Squatinella mutica (Ehrenberg) = *Stephanops muticus* Ehrenberg, 3, 5, 6, 12.
Trichotria pocillum (Müller) = *Dinocharis pocillum* (Müller), 1, 5, 6, 10.
Trichotria tetractis (Ehrenberg) = *Dinocharis tetractis* Ehrenberg, 2, 5, 6, 7, 10.
Wolga spinifera (Western) = *Distyla spinifera* Western, 4.
Lophocharis oxysternon (Gosse) = *Metopidia oxysternon* Gosse, 1, 3, 6.
Macrochaetus collinsii (Gosse) = *Dinocharis collinsii* Gosse, 5.
Scaridium longicaudum (Müller), 1, 3, 5, 8.
Trichocerca longiseta (Schränk) = *Rattulus longiseta* (Schränk), 5.
Trichocerca scipio (Gosse) = *Rattulus scipio* (Gosse), 5.
Diurella brachyura (Gosse), 1, 6.
Diurella tigris (Müller), 1.
Diurella tenuior (Gosse), 1, 6, 11, 12.
Diurella weberi Jennings, 1, 2, 6.
Synchaeta oblonga Ehrenberg, 6, 10.
Synchaeta pectinata Ehrenberg, 1, 4, 8, 10.
Synchaeta stylata Wierzejski, 8.
Synchaeta tremula (Müller), 1, 2, 3, 5, 9, 10, 12.
Polyarthra trigla Ehrenberg = *Polyarthra platyptera* Ehrenberg, 1, 2, 4, 6, 7, 8, 9, 11, 12.
Asplanchna brightwellii Gosse, 1, 2, 4, 9.
Asplanchna priodonta Gosse, 1, 4.
Asplanchnopus multiceps (Schränk), 4.
Testudinella patina (Hermann) = *Pterodina patina* (Hermann), 3.
Pedalia mira (Hudson) = *Pedalion mirum* Hudson, 3, 4.
Filinia longiseta (Ehrenberg) = *Triarthra longiseta* Ehrenberg, 8.
Floscularia ringens (Linnaeus) = *Melicerta ringens* (Linnaeus), 1, 5, 6, 10, 12.
Ptygura crystallina (Ehrenberg) = *Oecistes crystallinus* Ehrenberg, 6, 12.
Ptygura mucicola (Kellicott) = *Oecistes mucicola* Kellicott, 12.
Ptygura longipes (Wills) = *Oecistes umbella* Hudson, 6. Not previously found in the United States.
Ptygura velata (Gosse) = *Oecistes velatus* Gosse, 6, 10.
Collotheca cornuta (Dobie) = *Floscularia cornuta* Dobie, 1, 6.
Collotheca coronetta (Cubitt) = *Floscularia coronetta* Cubitt, 1, 6.
Collotheca ornata (Ehrenberg) = *Floscularia ornata* Ehrenberg, 6.
No study was made of the Bdelloida.

PLEUROTROCHA DAPHNICOLA (Thompson).¹

Plate 41, figs. 4-9.

Proales daphnicola THOMPSON, Science Gossip, vol. 28, 1892, p. 220, text figure.—MURRAY, Trans. Royal Soc. Edinburgh, vol. 45, 1906, p. 179, pl. 6, fig. 26.
Pleurotrocha sigmoidea SKORIKOV, Trav. Soc. Nat. Kharkow, vol. 30, 1896, p. 284, pl. 7, fig. 8.

Thompson's original description is very good and there is but little to add to Mr. Myers's figures of the animal, plate 41, figures 4 and 5; Thompson calls attention to the "remarkably long" foot glands with "their ducts plainly opening as projecting tubules at the extremity of the large, swollen toes." At the base of the toe there is a fairly large mucus reservoir.

The trophi, figures 6 to 9, present an interesting modification of the virgate or "pumping" type. The rami are approximately hemispherical, cuplike structures, functioning as the cylinder of the "pump"; of the usual transverse ridges only the basal one is present, taking the form of a prominent, hornlike process. On the inner surfaces of the rami, from the tip of the horn to the posterior or dorsal point, there is a series of close-set, needlelike teeth, shown in figure 8. These teeth obviously play no part in the mastication of the food, but they explain fully how the animal attaches itself to the skin of worms, as reported by Murray in the paper cited above. The unci rest on the dorsal portions of the rami, in the sinus behind the ventral horn. Each uncus has five teeth, two ventral, pointed, and three dorsal, with rounded, knoblike tips.

EXPLANATION OF PLATES.

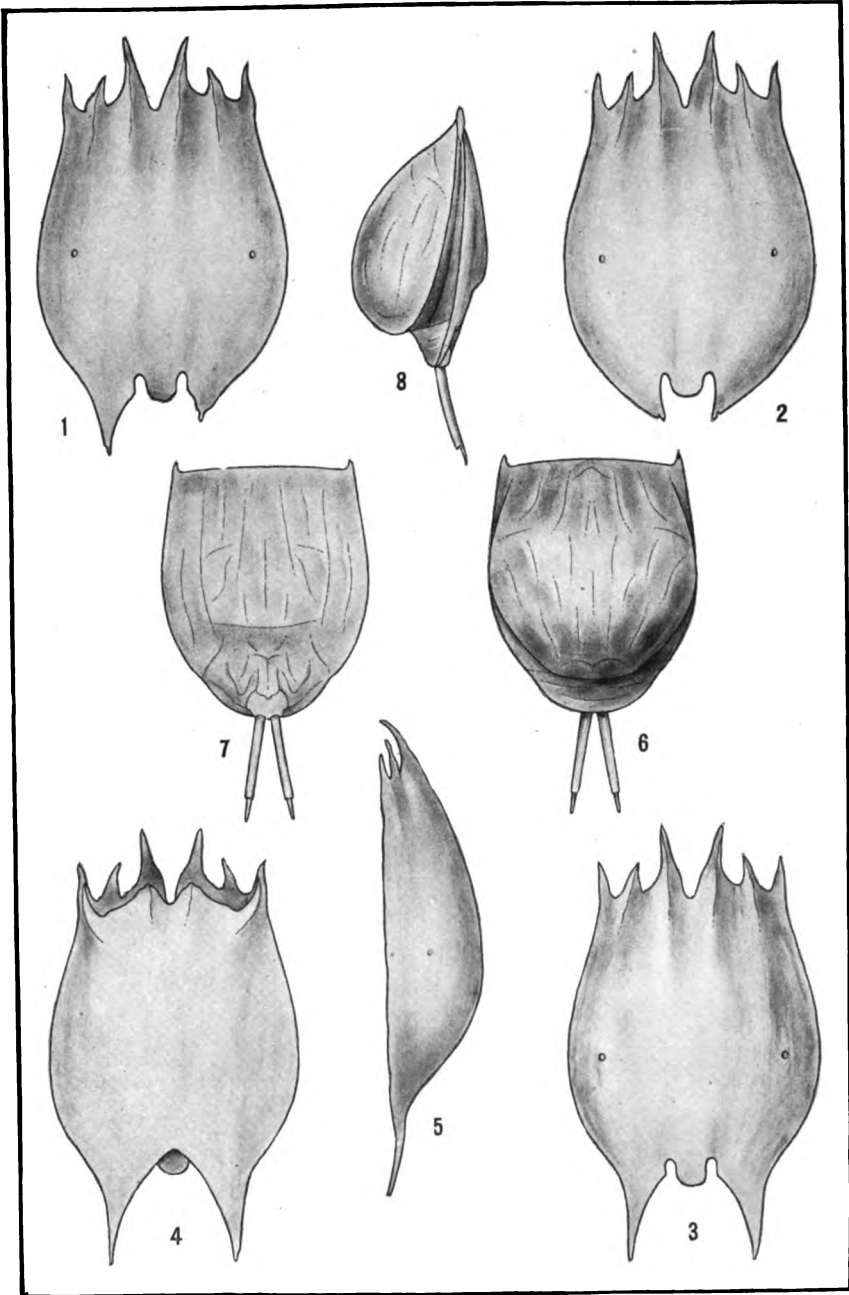
PLATE 40.

- FIG. 1. *Brachionus variabilis*, dorsal view; page 475.
2. *Brachionus variabilis*, dorsal view.
3. *Brachionus variabilis*, dorsal view.
4. *Brachionus variabilis*, ventral view.
5. *Brachionus variabilis*, lateral view.
6. *Lecane aspasia*, dorsal view, page 476.
7. *Lecane aspasia*, ventral view.
8. *Lecane aspasia*, lateral view.

PLATE 41.

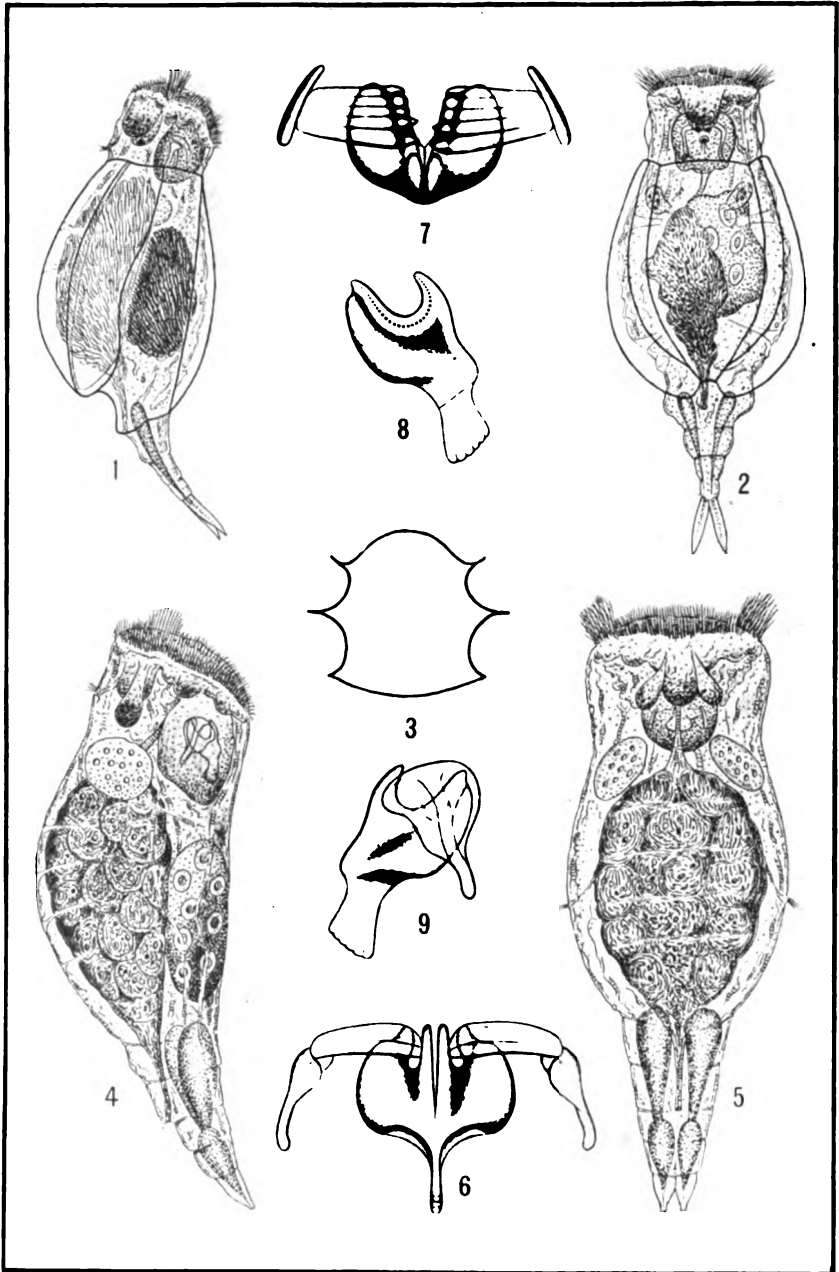
- FIG. 1. *Euchlanis plicata*, lateral view; page 475.
2. *Euchlanis plicata*, dorsal view.
3. *Euchlanis plicata*, transverse section of body.
4. *Pleurotrocha daphnicola*, lateral view; page 478.
5. *Pleurotrocha daphnicola*, dorsal view.
6. *Pleurotrocha daphnicola*, trophi, ventral view.
7. *Pleurotrocha daphnicola*, trophi, anterior view.
8. *Pleurotrocha daphnicola*, internal surface of left ramus.
9. *Pleurotrocha daphnicola*, trophi, lateral view.

¹ Note by H. K. Haring, U. S. National Museum.



ROTATORIA FROM LOS ANGELES, CALIFORNIA.

FOR EXPLANATION OF PLATE SEE PAGE 478.



ROTATORIA FROM LOS ANGELES, CALIFORNIA.

FOR EXPLANATION OF PLATE SEE PAGE 478.

ON CERTAIN SECONDARY SEXUAL CHARACTERS IN THE
MALE RUDDY DUCK, *ERISMATURA JAMAICENSIS*
(GMELIN).

By ALEXANDER WETMORE,

Of the Biological Survey, United States Department of Agriculture.

Among recorded peculiarities of the ruddy duck (*Erismatura jamaicensis*) the lack of an enlargement at the bronchial bifurcation of the trachea in the male has been most noteworthy. The absence of this *bullæ ossea* is the more striking as such an ampulla is developed with comparatively few exceptions among all of the river and sea ducks. MacGillivray,¹ apparently the only ornithotomist to examine and describe the trachea in the ruddy duck, first noted this peculiarity. Forbes found that a *bullæ ossea* was lacking also in the male of the Australian duck, *Biziura lobata*, and in his discussion of this fact calls attention² to MacGillivray's note on *Erismatura*. Later Beddard³ noted that males of *Oidemia nigra* and *Oidemia fusca* also lack this modification of the syrinx but did not give full enough credence to MacGillivray's account to include *Erismatura* in the same category unreservedly. In dissections of *Erismatura jamaicensis* made recently I have verified MacGillivray's observations of eighty or more years ago and have found in addition a remarkable secondary sexual structure that has apparently never been described.

Ornithologists who have skinned and prepared various species of ducks are familiar with the fact that in the ruddy duck the skin of the neck is full and loose, slipping easily over the occiput. In most other species of ducks it is necessary to slit the integument of the neck in skinning out the head. While examining a fresh specimen of the male ruddy duck my attention was attracted to the broad development of the paired dermal muscle (the deeper layer of the *cucullaris*) covering the ventral side of the skin of the neck. Further examination revealed a median broadening of the muscle *sterno-trachealis* and finally a remarkable tracheal air-sac which is used when males are displaying during mating. This tracheal air-sac has no connection with the pulmonary air-sacs of the body. It opens as a

¹ Audubon, J. J., *Ornithological Biography*, vol. 4, 1838, p. 331.

² Forbes, W. A., *Collected Scientific Papers*, 1886, p. 356.

³ Beddard, F. E., *Structure and Classification of Birds*, 1898, p. 464.

depression in the dorsal wall of the trachea immediately behind the larynx and lies between the trachea below and the esophagus above. When fully distended this air-sac like those of the pulmonary system is found to have thin transparent walls. In form it is somewhat pear-shaped, flattened ventrally and rounded dorsally. The anterior end for a space of 8 or 10 mm. is narrow, forming a slender neck which broadens abruptly into the body of the sac. In one specimen (Cat. No. 224829, U.S.N.M.), the distended sac measured 50 mm. long by 43 mm. broad. The depth was equal to the lateral measurement (43 mm.). In another (Cat. No. 224831, U.S.N.M.) the vesicle measured 65 mm. long by 32 mm. wide at the broad basal end. The diameter of the anterior extension or neck of the sac in this bird was 10 mm. In a third bird (Cat. No. 224832, U.S.N.M.) the measurements were intermediate between these two.

In dissecting these ruddy ducks I found that the paired dermal muscles (called by Gadow¹ the deeper layer of the muscle *cucullaris*) arise on the side of the head posterior to the orbit and pass backward converging immediately below the larynx until separated by only the space of a millimeter. The two muscles expand at once to cover entirely the loose skin of the ventral sides of the neck. They insert by two strong attachments on the furculum. For its anterior half each muscle is a single broad sheet. Posteriorly, (covering the tracheal air-sac) each divides into 20 or 22 fasciculae. While the lateral bands of each muscle are thin and weak the series of fascicles increases markedly in strength as the median line is approached. MacGillivray, in his notes on the trachea in the male ruddy duck,² remarks that the tracheal muscles are similar to those of other ducks but in this he was mistaken. The paired muscle *sterno-trachealis* is inserted as a slender band on either side of the thyroid cartilage. Passing back on reaching the anterior end of the tracheal air-sac it broadens suddenly to a width of 10 mm. The anterior edge of the expansion attaches firmly at its outer angle to the esophagus. Each muscle narrows gradually until at the posterior margin of the air-sac it is only 2 mm. wide. It is closely attached to the air-sac touching the trachea only along its internal edge. Posteriorly the entire narrowed muscle transfers rather abruptly from the air-sac to the trachea.

The depression marking the mouth of the air-sac is immediately behind the larynx on the dorsal surface of the trachea (fig. 1, *d*). Its sides are abrupt and it is broad anteriorly, somewhat constricted medially, and truncated posteriorly. From its posterior end leads the canal for the passage of air. In one specimen examined four of the anterior tracheal rings are interrupted over the opening of the canal; in another these rings are entire.

¹ Gadow, Hans, *Bronn's Klassen und Ordnungen des Thier-Reichs. Vögel*, vol. 1, 1891, p. 215.

² Audubon, J. J., *Ornithological Biography*, vol. 4, 1838, p. 331.

The internal structure of the larynx in the male ruddy duck is peculiar. Behind the rima glottidis (fig. 1, b) on either side is an elongate cushion of connective tissue from which a somewhat triangular elevation projects into the cavity of the larynx (fig. 1, c). These pads may be called the *pulvini laryngis*. In addition there is a flap of connective tissue developed along the median line of the thyroid cartilage for the length of the larynx. This flap is between 4 and 5 mm. high and is bent over toward the left side. It is not mentioned certainly in anatomies save by Sir Richard Owen¹ who speaks of finding it in "the Pelican, the Gigantic Crane, and most of the Rasores." I have called it the *ligula laryngis*. Apparently it has the same function as the mammalian epiglottis. From a study of the larynx in fresh birds I believe the probable mechanics of inflating the tracheal air-sac to be as follows: The male ruddy duck about to display fills the air-sacs of the pulmonary series with air. The rima glottidis is then closed by the action of muscles controlling the arytenoid cartilages. This brings the points of connective tissue (*pulvini laryngis*) in the larynx together and these with the *ligula* close the larynx save behind. With the sterno-tracheal and cucullaris muscles relaxed a slight contraction of the respiratory muscles would inflate the tracheal air-sac. Though no sphincter muscle is present, contraction at the anterior attachment of the *sterno-tracheales* may close the aperture of the air-sac by pressing the esophagus against it. The release of this pressure and contraction of the broad dermal muscle would serve to deflate the sac.

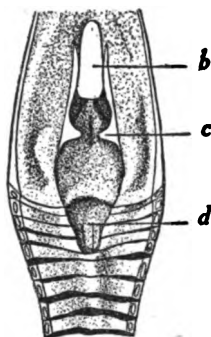


FIG. 1.—LONGITUDINAL SECTION OF LARYNX OF MALE RUDDY DUCK FROM BELOW (X2). b, RIMA GLOTTIDIS. c, PULVINUS LARYNGIS, d, MOUTH OF AIR-SAC.

The tracheal air-sac is absent in females. The deeper layer of the muscle *cucullaris* too is less in bulk than in males and the *sterno-trachealis* shows no unusual broadening. In a young male about 10 days old, however, a tracheal sac was present that measured when inflated 18 mm. long by 15 mm. wide (Cat. No. 224830, U.S.N.M.). It was placed as in the adult male. From examining this bird it was apparent that the sac grows by backward expansion from the opening in the trachea. The development of the *sterno-trachealis* muscle in the young bird was extraordinary. It spread over the entire ventral surface of the sac, covering it completely.

Adult males that were seen in display swam about with swelling breast and neck drawn in, turning or alternately advancing and retreating before the females. At short intervals the head was

¹ Owen, Richard, Comparative Anatomy and Physiology of Vertebrates, vol. 2, 1866, p. 219.

extended with a series of short jerks as the male called *tick-tick-tickity quo-ack*. At the last note the bill opened widely and the head was thrown forward, and then immediately withdrawn to the first position, when the display continued as before.

There is little question that similar air-sacs will be found upon examination in other species of the genus *Erismatura* as recognized at present. Kerr¹ in describing the courtship of *E. vittata* (witnessed near Buenos Aires, Argentina) says that at one stage the male "stretches out his neck on the surface of the water right in front of him, and then ruffles up the feathers of his neck and *inflates his crop* [*italics mine*] until his neck seems to disappear altogether." And Bennett² writing on *E. australis* says that this species has habits identical with those of *E. vittata* as described by Kerr³ "even to the peculiar manner of courtship adopted by the male bird." From examination of study skins of males of other species of ducks in the collections of the United States National Museum, that are placed now in the anatine subfamily *Erismaturinae*, it is expected that tracheal air-sacs similar to that described in the male ruddy duck may be found. The additional species seen are:

Thalassornis leuconotus (Smith).

Thalassornis insularis Richmond (female only seen).

Nomonyx dominicus (Linnaeus).

Erismatura leucocephala (Scopoli).

Erismatura ferruginea Eyton.

All these species have the skin of the neck full and loose so that in no case was there a slit made around the head by the collectors who prepared the birds. In addition the skin on the necks of these birds beneath the feathers is thick and leathery to the touch as though underlaid by heavy dermal muscle.

It is worthy of note that in the species of ducks at present known to have no dilation of the syrinx in the males some other peculiarity of the trachea or mouth is present. According to Forbes³ in *Biziura lobata* there is a small distensible sac contained in a loose gular fold of skin with its opening in the mouth anterior to the *fraenum linguae*. In *Oidemia nigra* the trachea and the bronchi of the male are both somewhat dilated. *Oidemia fusca* has a remarkable swelling below the larynx containing a separate chamber communicating by two slits with the trachea. The peculiarities of *Erismatura jamaicensis* are described in this paper.

¹ Kerr, J. G., Extracts from letters of, *Ibis*, 1890, p. 360.

² Bennett, K. H., Letter from, *Ibis*, 1891, p. 143.

³ Forbes, W. A., Collected Scientific Papers, 1885, pp. 355-356.

NOTES ON THE LIFE HISTORY AND ECOLOGY OF THE DRAGONFLIES (ODONATA) OF CENTRAL CALIFORNIA AND NEVADA.

By CLARENCE HAMILTON KENNEDY,
Of Cornell University, Ithaca, New York.

INTRODUCTION.

This is the second of three general papers on Pacific Coast Odonata. The first concerned Washington and Oregon Odonata.¹ The third, which is now in preparation, will be based on collecting done in southern California during the summer of 1915.

The object of this series is, first, to give a view of Pacific coast dragonflies and their varied and interesting environments, and, second, to bring the data together on which a list of western Odonata can be written. This list is now in preparation and, covering that area of Canada and the United States west of the one hundredth meridian, already includes nearly 200 species.

In the present paper, as in the first, I have made descriptions and illustrations as complete as possible because much of the literature on western dragonflies is inaccessible to even the average college student.

The trip to Nevada was made possible by a liberal advance of money from Mr. E. B. Williamson, who later received his pay in a series of the specimens collected. At all times in the work I have received his constant encouragement and help. The greater part of the work on the paper was done in the Stanford University laboratories under Prof. Vernon L. Kellogg, whose kindly appreciation and critical help have been among the pleasures of the undertaking. The paper was completed in the Cornell University laboratories, where Dr. J. G. Needham very kindly assisted me on the gomphines.

A series of specimens covering all the forms discussed in the following pages, except such as are specifically stated to be elsewhere, has been deposited in the United States National Museum.

1. A PACIFIC COAST VARIETY OF *AGRION AEQUABILE*.

Since my arrival at Cornell I have received a shipment of interesting California Odonata from Mr. and Mrs. L. R. Reynolds, of San Francisco. These were interesting in that several species were taken at altitudes of 8,000 to 10,200 feet in the Sierras. These are listed in the final section of this paper.

¹ Kennedy, C. H. Notes on The Life History and Ecology of The Dragonflies (Odonata) of Washington and Oregon. Proc. U. S. Nat. Mus., vol. 40, pp. 259-345, July 23, 1915.

Among these were a male and female *Agrion aequabile* (Say), the first recorded from California, which were larger than var. *yakima* and had slightly more color in the wings. These are apparently an undescribed race. This is the third variety of *aequabile* found in the West, var. *yakima* being found in the Columbia River basin, var. *coloradicum*¹ described from Boulder County, Colorado, and this form now found in California.²

Mr. and Mrs. Reynolds have very kindly deposited these specimens in the United States National Museum.

AGRION AEQUABILE CALIFORNICUM, new variety.

Type.—Cat. No. 20814, U.S.N.M. A male from the collection of L. R. and C. D. Reynolds, taken at Blue Lake, Humboldt County, California, May 6, 1911, by F. W. Nunenmacher.

Allotype.—Cat. No. 20814, U.S.N.M. A female from the collection of L. R. and C. D. Reynolds, taken at Blue Lake, Humboldt County, California, May 6, 1911, by F. W. Nunenmacher.

Male, color.—Thorax and abdomen metallic blue, except the second lateral suture, the metepisternal keel and the dorsal edge of the metinfraepisternum, which are creamy. Coxae and legs black. Pterostigmas absent. Wings (fig. 1) flavescent with the apices dark. The specimen is teneral so that the wings are not as dark as in the figure. The front wings are dark on the apical three-fourths of the distance from nodus to apex. The hind wings are dark on the apical four-fifths of the distance along the costa from the nodus to the apex. In the front wings the basal edge of the dark area is vertical to the costa. In the hind wings it slants from the costal edge toward the base of the wing, reaching the anal margin opposite the nodus.

Female, color.—Similar to that of the male but general body color metallic green. Labrum creamy with a black center. Abdominal segments 8–10 with a middorsal pale stripe and their sides largely pale. Wings (fig. 2) with white stigmas. Front wings with the dark area covering the apical three-fifths of the distance from nodus to apex. In the hind wings the dark covers, along the costa, the apical three-fourths of this distance. The basal edge of the color is perpendicular to the costa in the front wings and diagonal in the hind wings.

Male, abdomen (including appendages), 40 mm.; appendages, 15; hind wing, 32. Female, abdomen, 39; hind wing, 35.

2. NOTES ON LESTES STULTUS AND ITS NYMPH.

This black *Lestes* was described in 1861 by Hagen³ from a single mutilated male in the Museum of Comparative Zoology. Since that

¹ Cockerell, T. D. A., *Psyche*, vol. 20, 1913, p. 173.

² Since writing this I have found in the Cornell collection a male *Agrion aequabile yakima* taken at Corvallis, Oregon, June 20, 1896. This is west of the crest of the Cascade Mountains. In the collection of the U. S. Biological Survey in Washington, D. C., are a male and a female of *Agrion aequabile* collected on the Owyhee River, Rome, Malheur County, Oregon, June 20, 1915, which are intermediate between variety *yakima* and variety *californicum*. Other specimens of *californicum* from Seattle, Washington, are in the collection of Dr. Philip P. Calvert.

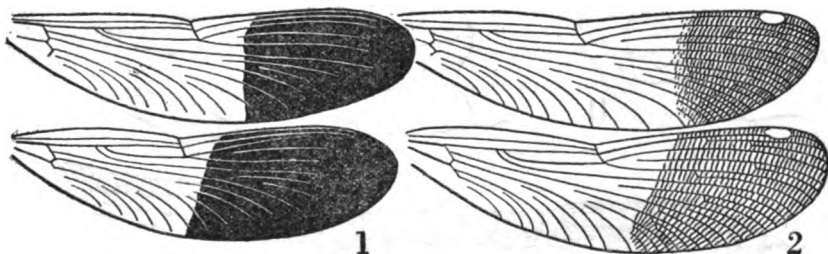
³ *Syn. Neur. N. Amer.*, 1861, p. 67.

time few specimens have been taken. I found it common in the San Francisco Bay region and extending up the Sacramento Valley as far as Marysville. Probably it will be found throughout the Sacramento and San Joaquin valleys. I can see no difference between the habits of this and those of *disjunctus* and *unguiculatus* with which it is usually associated. This is the earlier of the three species but their periods overlap. *L. stultus* at Palo Alto, California, emerges in April and May and is scarce by the middle of July. It is distinctly a slough or pond species. (See figs. 3-10, 14-18.)

During May this species was very abundant about the small ponds on the crest of the Coast Mountains west of Stanford University. By July 15 it had been largely displaced about these ponds by *disjunctus*.

LESTES STULTUS Hagen.

Male, color.—Labrum, vertical surface of clypeus, bases of mandibles and genae pale pure blue. Dorsal surface of clypeus, frons,

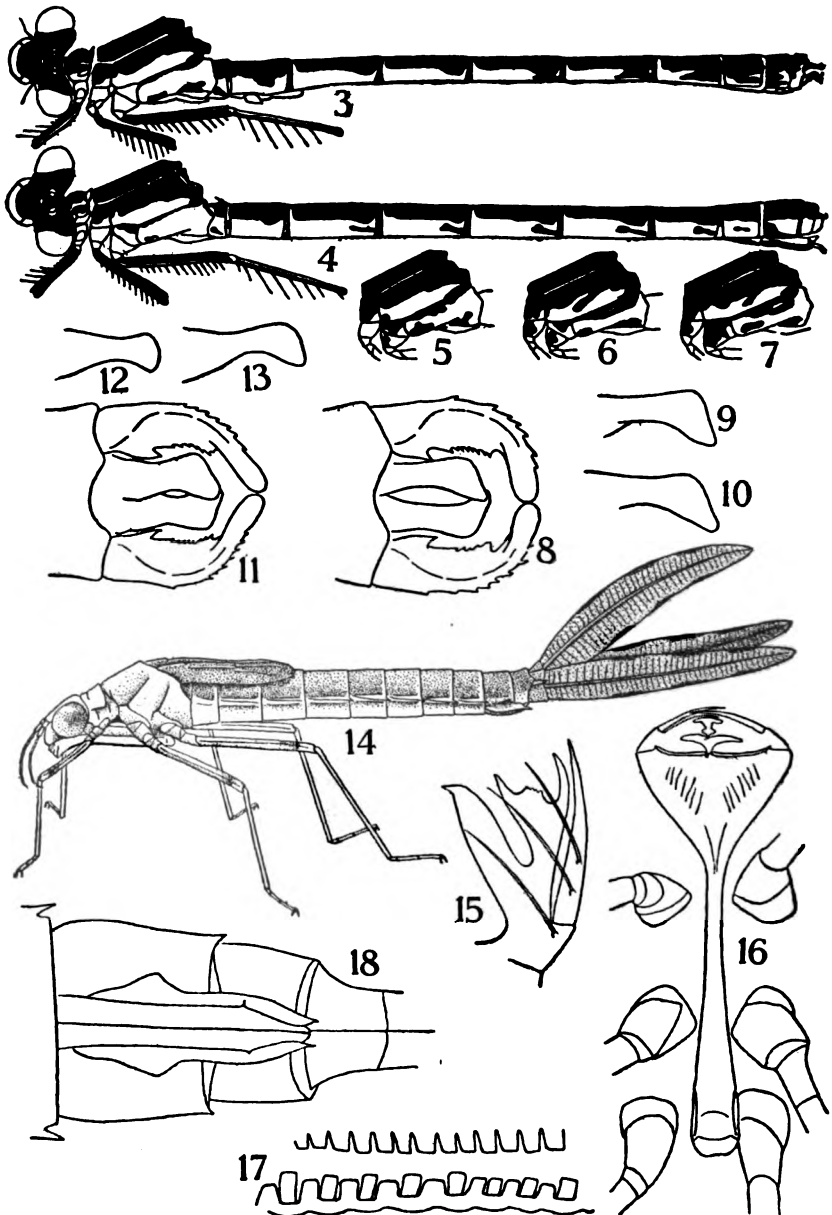


FIGS. 1-2.—*AGRION AEQUABILE CALIFORNICUM*. 1. WINGS OF MALE. 2. WINGS OF FEMALE.

vertex, and postocular areas black, except a minute pale area external to each lateral ocellus. Eyes pale pure blue above, grayish below. (See fig. 3.)

Prothorax black except a pale creamy stripe below the edge of the lateral lobe and another pale stripe just above the coxa. Coxa usually pale, in some individuals with an external black spot. Legs creamy with an external black stripe on trochanter and femur, an internal black stripe on tibia, and tarsus black. Mesothorax and metathorax with anterior surface black except in some individuals middorsal keel narrowly creamy. In all a narrow antehumeral pale bluish green stripe extending not quite to the antealar ridge. Upper half or two-thirds of mesinfraepisternum black. Sides of thorax creamy with bluish areas, except some black anterior to first lateral suture, the demarcation angulated or irregular. Second lateral suture narrowly and irregularly black, in some individuals followed by an irregular black stripe (see figs. 5-7). Metepimeron with a black spot on its lower anterior edge. In some individuals a spot on the posterior third of the metasternum. Metinfraepisternum entirely pale or with its upper third black. Coxae creamy or with a black spot. Legs colored as those on the prothorax. Pterostigmas black.

Abdomen with dorsum broadly black with greenish and purplish reflections, except a narrow pale ring on base of segments 2-8. Pale



FIGS. 3-10, 14-18.—*LESTES STULTUS*. 3-4. USUAL COLORATION. 5-7. VARIATION IN THORACIC PATTERN. 8-10. APPENDAGES OF MALE. 14-18. NYMPH.

FIGS. 11-13.—*LESTES UNCATUS*, APPENDAGES OF MALE.

areas creamy. Segments 2-7 with a narrow, black apical ring. On segments 5-7 and in some individuals also on 8 and 9 there is an irregular black blotch in the lower apical angle which is broadly con-

nected with the black of the dorsum. Segments 3-9 with sternum black; creamy on 1, 2, and 10. Superior appendages black; inferior pale. Segments 9 and 10 heavily pruinose.

Female, color.—Colored like the male but with a dumbbell-shaped black spot in the lower apical angle of segments 3-8, which is not connected with the dorsal black. Segment 9 with a large black blotch on its lower anterior angle. Genital valves broadly black on their lower edge. (See fig. 4.)

The teneral colors of *stultus* are similar to those of the teneral *uncatus*; a general color of salmon pink with pale bronzy markings.

The color pattern is quite variable but differs from that of *uncatus*, its nearest relative, in being always black, where in *uncatus* it is always metallic green; in the well developed blue antehumeral stripe, where in *uncatus* there is seldom even the slightest indication of one, and in the less amount of black on the legs; in *uncatus* the legs are black except an internal stripe on the femur and a mere hair line of pale on its exterior surface, and a very short, narrow, exterior pale line on the proximal end of the tibia.

Structurally *stultus* differs from *uncatus* in its greater size, as is shown in the following comparative measurements:

	abd., male.	h.w., male.	abd., female.	h.w., female.
<i>stultus</i>	30-34	21-23	32	26
<i>uncatus</i>	26-28	20-21	27	24

The individual *stultus* the abdomen of which measures 30 mm. in the table is unusually small. The average is around 33 or 34. The male appendages are very similar, as is shown in figures 11-13 (*uncatus*) and 8-10 (*stultus*). In *stultus* the inferior appendages have a slightly more acuminate point than in *uncatus*.

The description of the nymph of this species which follows is based on exuviae collected on "Mud Lakes" west of Stanford University during May, 1915. As these were collected when *stultus* was abundant and no *disjunctus* were caught I did not doubt their authenticity until I returned in July and found but few *stultus* flying and *disjunctus* abundant. Probably they are *stultus*.

Nymph.—A long slender nymph (figs. 14-18) much larger than its nearest relative, *uncatus*.

Labium (figs. 15-17) long and slender, reaching back to middle of hind coxae or even to their hind margin. The proximal part of the mentum is about two-thirds of its length, and its breadth is less than one-eighth of the width of the mentum at the bases of the lateral lobes. It expands proximad to three times its middle breadth. Mental setae 7. Lateral setae 3, two on the movable hook and one on base of lateral lobe. Lateral lobe of same general shape as that

of *uncatus*.¹ Teeth along distal edge of mentum and on internal edge of the lateral lobe similar to those figured by Walker for *unguiculatus*.² Antenna seven jointed.

Wings short, reaching beyond middle of third segment. Lateral spines on segments 5-9. Hind femur reaching to beyond apex of third segment; 8-11 spicules on lateral carina of segment 9. Ovipositor reaching just beyond apex of segment 10 and styli of valves slightly beyond ovipositor. Ventral edge of valves with a row of five or six minute spinules, no hairs. Gills sickle-shaped, the median curved down and the two laterals curved up, each broadest at the proximal third, tapering thence to the obtusely pointed apex. Edges of gills with conspicuous spinules (none on *uncatus*). Each gill with three spots on its dorsal edge and three on its ventral edge. Apices of femora with a dusky ring, otherwise no color pattern. Length without caudal gills, 21-23 mm.; gills, 12 mm.; hind femur, 5.5 mm.

The nymph of *stultus*, if that is what these specimens are, is close to that of *disjunctus*. Since writing the preceding description I reared a *disjunctus* nymph from these same Mud Lakes. This reared nymph agrees in detail in size, numbers of spines, etc., with Walker's description of *disjunctus* nymph. On comparing it with the *stultus* exuviae I find these larger, the caudal gills hardly as acuminate, the spicules on the lateral keel of segment 9, 12-13 in number. I should have supposed that the *stultus* nymph would be closer to *uncatus*.

3. A NEW GENUS BASED ON AGRION EXCLAMATIONIS.

ZONIAGRION, new genus.

Arculus placed at or near the second antenodal; M_2 arising basad of the sixth postnodal in the front wing and basad of the fifth postnodal in the hind wing; anal bridge separating from the hind margin of the wing as far before the anal crossing as the latter is long; three post-quadrangular cells; antenodal costal spaces with the second space slightly more than half the length of the first and slightly less than half the length of the third; quadrilateral of fore wing with basal side contained in the distal side 2-2.75 times and in the posterior side 3.5 times; anterior side varying greatly, from 1-2 times length of basal side. Stigmas alike in front and hind wings; costal and posterior margins equal; either slightly longer than the proximal or distal margins, which are equal.

Female with a large apical spine on the ventral side of segment 8. Male with segment 10 terminating dorsally in a fork which is slightly higher than the anterior end of the dorsum. Shaft of penis with spines, the tip spatulate; distinguished from that of 110 other agriine genera examined, including all the North American genera, by a

¹ See Can. Ent., vol. 46, p. 199, pl. 14, fig. 9, *uncatus*, mental lobe.

² Idem, p. 349, pl. 23, fig. 1, *unguiculatus*, mental teeth.

transverse row of short spines at the base of the distal or spatulate lobe (see figs. 24 and 32, and compare with figs. 35 and 38-42).

Color blue and black, with blue postocular spots and a striped thorax.

This genus differs from *Coenagrion* in the male having nine external tibial spines and the female having a vulvar spine, also in the penis, which in typical *Coenagrion* (*puella* Linnaeus) has a divided tip (see fig. 42). It differs from *Enallagma* in the high forked apex of segment 10 in the male, in the coloration, and in the penis which in *Enallagma* is of the type shown for *Enallagma civile* Hagen (see fig. 41).

From *Ischnura* it differs in having stigmas similar in front and hind wings and in the origin of M_2 as well as in the penis (see figs. 70-81). From *Acanthagrion gracile* (fig. 37) it differs in that A arises basad of the anal crossing. (See also figs. 33, 34, and 36.)

Type of the genus.—*Agrion exclamatoris* Selys.¹

The name proposed is suggested by the heavily banded caudal gills of the nymph. *Ζώνιον*=a little girdle; *ἄγριον*=living in the fields, wild, savage—the name of a genus of dragonflies.

4. NOTES ON ZONIAGRION EXCLAMATORIS AND ITS NYMPH.

It was my good fortune to rediscover Selys's *Agrion exclamatoris*. This species had been described by Selys in 1876 from a single male in the collection of McLachlan, since which time no other specimens had been collected. (See figs. 19-32, 43-52.)

On May 17, 1914, while collecting west of the Stanford campus, I found this species very abundant about the permanent pools in San Francisquito Creek. It was most abundant in the half mile below the Searsville dam. Two hundred feet below the dam was a pool fifteen feet across and four feet deep the sides of which were bordered by mud banks fringed with a rank growth of *Sparganium*. A few males and numerous females were flying in and out among the rank stalks of this plant, while several females were ovipositing in the tips of the leaves which hung over and touched the surface of the water.

The eggs are inserted in the tissue of the leaf blade in a zigzag row (see figs. 50-52). The female, unassisted by the male, backs down until the abdomen is submerged, when she inserts the first or lowest egg of the series. The second is inserted after moving up a short distance. (In most agrionines the female moves down as she oviposits.) With each move up she moves slightly to one side or the other, leaving a zigzag row of incisions below her.

These *Sparganium* clumps had many exuviae of this species clinging to them. A careful examination of their roots, which hung in masses in the edges of the pool, brought to light several live nymphs. These were carried to the laboratory, where they emerged a few days later.

¹ Bull. Acad. Belg. (3), vol. 41, 1876, p. 1261.

A quarter of a mile below Searsville dam many pairs were caught about a pool shaded by large alders and in the open glades in the underbrush males were abundant.

During May I found a few individuals about a deep pool in Coyote Creek at San Jose, California. On June 11, 1914, I caught this species on the Sacramento River at Colusa, California, and on June 14, on the Chico River at Chico, California. On July 9 it was common in the willows along the San Lorenzo River near Santa Cruz, California. This was the last date on which it was seen. Thus the season extends from April to July.

Measurements: Length of abdomen: Male, 26-27 mm.; female, 20-22. Length of hindwing: Male, 20 mm.; female, 20-22.

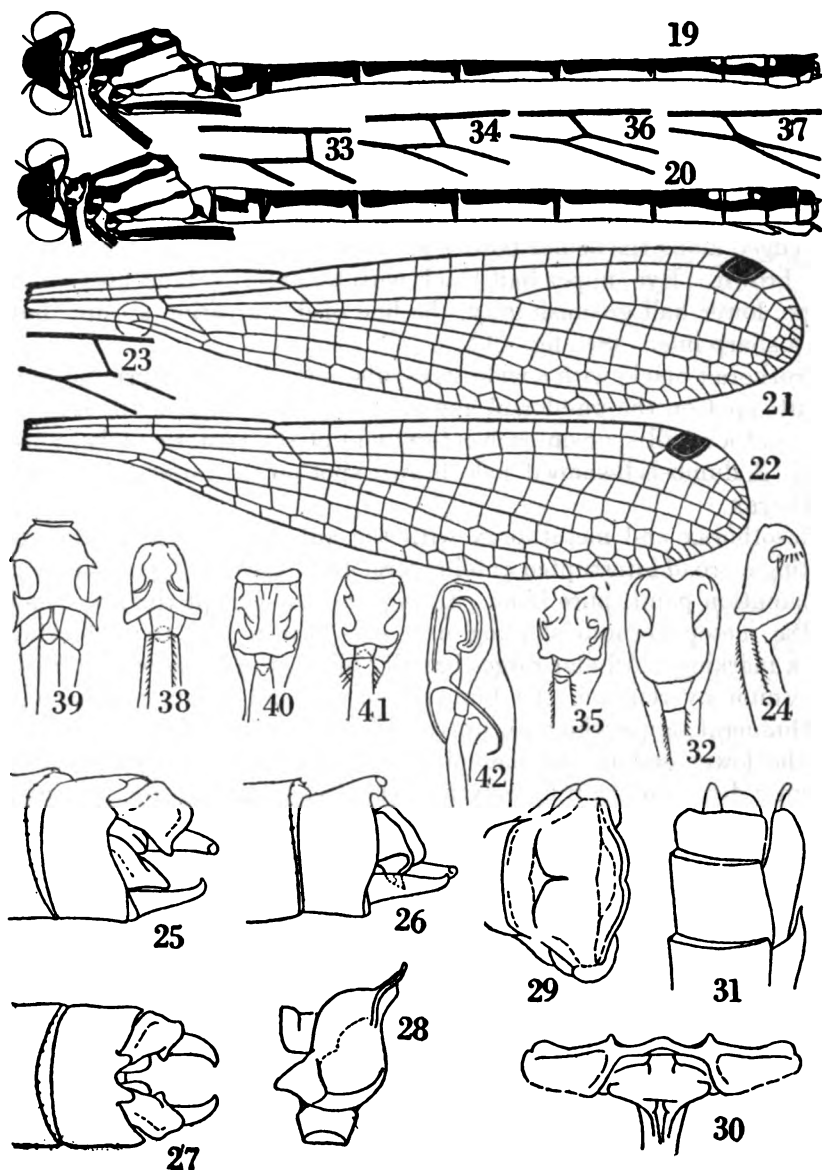
Male, structural notes.—Head wide, its extreme width twice its length. Antennal and fronto-vertical fossae well developed. Occipital ridge low. Prothorax with middle lobe divided along mid-dorsal line from front to center into two low, smoothly rounded halves (figs. 28-29). Posterior lobe thin, as much higher than the middle lobe as that is than the anterior lobe, erect (almost vertical), slightly emarginate on the posterior edge. Just ventrad of the lateral terminations of the posterior lobe the side of the prothorax is bulged into a conspicuous swelling.

Front femur with 4 internal and 6 external spines, middle with 9 internal and 8-10 external spines, hind with 8-9 internal and 8-9 external spines. Front tibia with 3 internal spines and 9 external, middle with 13 internal and 7-8 external, hind with 18 internal and 10 external spines. Hind femur reaching to middle of segment 2. Wings reaching to apical fourth of segment 6.

Pterostigmas equilateral, rhomboidal (almost square). A large hemispherical tubercle on ventrum of metathorax with a pair of conspicuous black spots on its anterior surface.

Posterior hamules low, rounded, not reaching the ventral edge of the genital fossa. A minute spine on inferior, anterior angle of side of segment 3. Abdomen slender. Segment 10 with a middorsal, apical, forked projection, which projects little above the middorsal contour. Inferior appendages with two branches, a flat branch extending dorsad and mesad and closely applied to the posterior end of 10 and a slender ventro-external branch as long as 10, this tapering regularly to its incurved slightly hooked tip. The dorsal appendages are thin and laminalike and curve abruptly mesad and ventrad, each terminating ventrally in a small point lying on the inner side of the base of the external branch of the respective inferior appendage. (See figs. 25-27.)

Female, structural notes.—Structure as in male except in the genitalia. Segment 10 one-half length of 9. Appendages three-fifths length of 10, broad with rounded tip. Segment 8 with a large flat



FIGS. 19-32.—*ZONAGRION EXCLAMATIONIS*. 19-20. COLORATION. 21-23. VENATION. 24 AND 32. PENIS. 25-27. MALE, APPENDAGES. 28-29. PROTHORAX. 30. FEMALE, MESOSTIGMAL LAMINAE. 31. SEGMENTS 9 AND 10 OF FEMALE.

FIG. 33.—*ENALLAGMA CARUNCULATUM*, BASAL POSTCOSTAL VEIN.

FIGS. 34-35.—*ACANTHAGRION INTERRUPTUM*. 34. BASAL POSTCOSTAL VEIN. 35. PENIS.

FIG. 36.—*ENALLAGMA HAGANI*, BASAL POSTCOSTAL VEIN.

FIGS. 37-38.—*ACANTHAGRION GRACILE*. 37. BASAL POSTCOSTAL VEIN. 38. PENIS.

FIG. 39.—*AMPHIAGRION SAUCIUM*, PENIS.

FIG. 40.—*ENALLAGMA POLLUTUM*, PENIS.

FIG. 41.—*ENALLAGMA CIVILE*, PENIS.

FIG. 42.—*COENAGRION PUELLA*, PENIS.

spine. Genital valves long, extending beyond apex of 10, denticulate along their ventral edge, stylus equaling appendages in length. (See figs. 30-31.)

Male, live color.—Labrum greenish blue, edged above with black. Base of mandible greenish blue edged basally with black. Nasus, vertical surface of frons, genae and base of mandibles greenish blue. Post-clypeus, dorsal surface of frons and vertex black, except the large, triangular, pure blue postocular spots. Rear of head black but edged along the ocular border with a wavy line of blue. Labium pale brown. Eye, upper half black with an anterior blue horizontal stripe, lower half greenish gray, the line of demarcation abrupt, but not a sharp line. (See fig. 19.)

Prothorax black, with a wide triangular spot on the anterior lobe, a minute spot on the middorsal line of the anterior edge of the middle lobe and a small spot on each lateral end of the posterior lobe, pure blue. A dumb-bell-shaped pale brown spot on the lower side of the prothorax.

Mesothorax and metathorax with the anterior surface black, excepting a broad interrupted antehumeral stripe resembling an inverted exclamation point, pure blue. Sides pure blue except the lower end of the metepisternum shading into pale brown and the following black markings: All alar ridges broadly black, the black of the mesepisternum overlapping the humeral suture and forming a narrow posthumeral stripe which abruptly widens below into a square spot on the lower end of the mesepimeron. A narrow wedge of black running down on the upper sixth of the first lateral suture. Second lateral suture broadly black, the dorsal third of this stripe dilated into an oval spot, the ventral end of the stripe continuous with an irregular black area on the anterior end of the metepimeron. Lateral metasternal keel broadly black. Mesinfraepisternum black except ventral third brown. Metinfraepisternum brown but broadly edged with black above. Ventral surface of thorax pale brown. All coxae black on their external and posterior surfaces (with usually a narrow brown spot on the ridge between these surfaces), their mesal surfaces brown. Trochanters and femora black externally, pale brown internally; tibiae and tarsi black. Wings hyaline; stigmas black. Abdomen black with blue and pale-brown markings. Segment 1 pure blue, except a baso-lateral, rectangular, black spot and a narrow apical, vertical stripe on each side.

Segment 2 black, except a pure blue rectangular spot occupying the anterior two-thirds of the dorsum and a broad greenish blue stripe along the ventral edge of the side.

Segments 3-6 black, except a narrow pale brown, basal ring, interrupted middorsally (but sometimes obsolete on segment 3) and a narrow pale-brown stripe along the ventral edge of the side.

Segments 7-10 black, with the narrow brown stripe along the ventral edge of the side, as in segments 3-6. Intersegmental membranes brown. A large subrectangular pure blue spot covering all the dorsum of 8 and extending caudad over the anterior third of 9 and cephalad over the posterior sixth of 7. Ventrums of segments 1, 9, and 10 brown, of segments 2-8 black. Appendages black with the bases of the inferiors brown.

Female, color of dried material.—Labrum brownish, edged above with black. Nasus gray. Genae and vertical surface of frons bluish gray. Postclypeus, horizontal surface of frons and vertex black. Postocular spots large, triangular, connected. Postoccipital areas black on internal and dorsal edges, pale cream on inferior, exterior edge. (See fig. 20.)

Prothorax black on dorsal surface with anterior lobe pale and posterior lobe edged with pale cream, sides creamy olive.

Mesothorax and metathorax colored as in the male, but the antehumeral pale stripe continuous, showing only a constriction where in the male is the break. The pale colors are less bright in the female, the antehumeral stripe being olive brown, with a narrow stripe of the same, posterior to the black humeral stripe, this shading into a pale bluish gray on the metepisternum. The pale areas of the posterior and inferior surfaces are creamy as are the pale areas of the legs. Wings hyaline with brown stigmas.

Abdomen colored as in the male, except that the dorsum of segment 9 is entirely black.

Nymph.—Length, exclusive of gills, 14 mm.; gills, 7.5; hind femur, 4; head, 3.5 wide. (See figs. 43-49.)

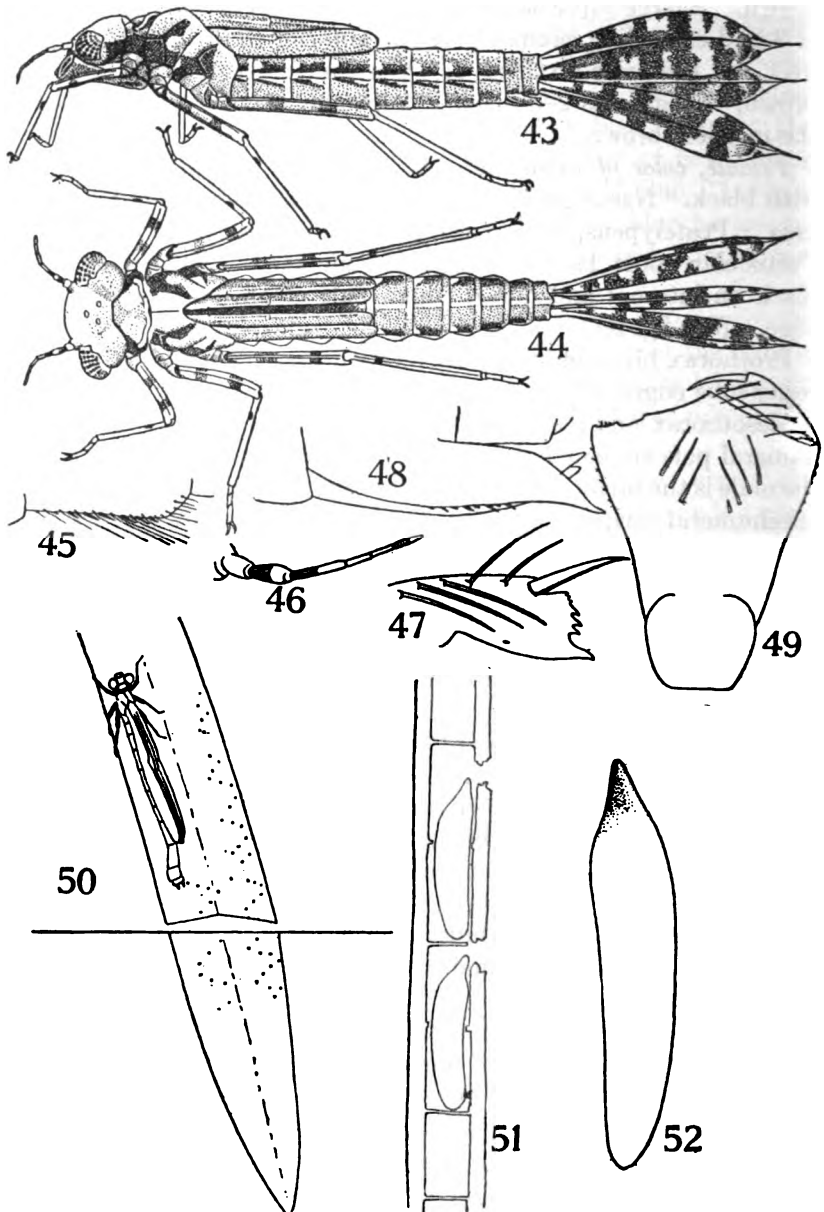
Color usually muddy brown with black markings.

Head wide, its length being five-ninths of its width. Occiput deeply concave. Postocular areas covered with numerous minute spicules. Dorsal surface very flat. Antennae seven jointed, the sixth and seventh closely united and appearing as one; segments 1 and 6 black, and the proximal half of segments 2 and 3 black. Eyes with a checker pattern.

Labium with three large mental setae on each side and occasionally a smaller one at the base of one or both rows. Five lateral or raptorial setae. Each lateral lobe with a large movable hook and several end teeth as follows: A large internal tooth set off from three smaller teeth, which are followed by three or four minute teeth on the outer side of the end (see fig. 47). Labium when closed reaching to the second coxae.

Prothorax with posterior lobe wide, each side of which is curved cephalad on the side of the prothorax, where it ends in a low prominence laterad of the middle lobe. Sides below the forward curve of the posterior lobe black.

Mesothorax and metathorax with a humeral stripe and a stripe on second lateral suture black. Infraepisterna black. Femora with a



FIGS. 43-52.—*ZONIAGRION EXCLAMATORIS*. 43-49. NYMPH. 45. LATERAL CARINA. 46. ANTENNA. 47 AND 49. MENTUM. 48. SEGMENT 9 OF FEMALE NYMPH. 50. FEMALE OVIPOSITING. 51. EGGS IN LEAF. 52. EGG.

dark basal and also subapical band and a paler median band. Tibiae with a black spot one-fourth the distance from the proximal end. (In a sketch of a live nymph I find on the femora a dark apical band,

preceded by an equal pale band, which is preceded by a very dark band. A narrow band occurs on the extreme base of the femora.) Femur of hind legs reaching apex of segment 4, and wings, which lie parallel, reaching to first third of segment 5.

Abdominal segments 1 to 8 with wide lateral keels; these edged with a single row of spicules and numerous long hairs (see fig. 45). Color brown, with median dorsal stripe and lateral keels white. A dark lateral stripe above lateral keel, a less conspicuous dark line below. Segments 2-7 each with a white spot above anterior end of lateral keel.

The male organ on segment 9 is as usual in Zygoptera. The vulva of the female has the outer valves edged with a row of 4-6 prominent spines. Between these are smaller spines and long hairs (see fig. 48).

The caudal gills narrowly oblanceolate, increasing in width to the apical third, where the lateral gills are one-sixth as wide as long and the median slightly more than one-sixth. From this point they taper suddenly to the apical sixth, the last sixth being the attenuate apex of the gill. The gills have two patterns of color—(1) a dark brown stripe of pigment bordering the rib from the base to the middle of the fin with a crescent of the same at the apex, and (2) a series of 5 or 6 intense black cross-bars produced by the pigmentation of the tracheal branches in these areas. Edges of gills fringed with hairs.

This nymph differs from *Enallagma* nymphs in having long hairs on lateral keel as well as spicules.

It differs from *Ischnura* in the female lateral vulvar valves having four or more spines (in *Ischnura* only one or two very small spines, in *Enallagma* four or more spines).

5. A NEW GENUS BASED ON ISCHNURA DENTICOLLIS.

CELAENURA, new genus.

Venation and stigmas as in *Ischnura*. Arculus at the second antenodal: M_2 arising basad of the fourth postnodal in the front wing and basad of the third postnodal in the hind wing; anal bridge separating from the hind margin of the wing as far before the anal crossing as the latter is long; three post-quadrangular cells in each wing except in the front wings of the types where there are four; antenodal costal spaces with the basal twice the length of the middle, and about three-fifths the length of the distal; quadrilateral of the front wing with the basal and anterior sides equal or the anterior slightly longer and either contained 2-2½ times in the posterior side (the preceding proportions vary considerably owing to the variability of the anterior side, which in one specimen is almost 1½ times as long as the basal side). Stigmas rhomboidal, in the male those of the front wings black, of the hind wings brown; the costal and distal edges slightly longer than the basal and posterior edges. Female with a minute, acute, ventral spine on the

apex of segment 8. Male with segment 10 terminating dorsally in a high narrow fork. Shaft of penis without a longitudinal row of spines; penultimate joint of penis without the pair of heavy spines found in *Ceratura*, *Anomalagrion*, and *Ischnura* (see figs. 85 and 92); ultimate lobe terminating in a fleshy fork, the branches of which curve dorsad and caudad, tapering regularly to acute points.

Color blue and black with blue postocular spots, the dorsum of the thorax solid black, the dorsum of the abdomen black except a blue dorsal spot on segments 7-9.

This genus is erected to contain *Ischnura denticollis* (Burmeister) and a new species almost identical in structure and color. The venation (figs. 86-87) is apparently like that of *Ischnura* but these species differ from the American species of *Ischnura* in having the anterior surface of the thorax solid black. In the structure of the penis they lack the pair of erect spines on the penultimate segment, which is characteristic of the penis of *Ceratura capriola* (Hagen) (fig. 82), *Anomalagrion hastatum* (Say) and *Ischnura pumilio* (Charp.) which are the type-species of their respective genera. In *Ischnura* (see figs. 70-81), I have examined over 20 species, including all the American species and find the penis to possess always the pair of erect spines on the penultimate segment, excepting one exotic species (*elongata* Martin), very evidently not an *Ischnura*.

The species of *Nehalennia* have been confused with *Ischnura*, *denticollis* having been placed in that genus by Kirby,¹ but, as seen by the figures 83-84, the *Nehalennia* penis is very different in structure. Also the female is without a spine on segment 8.

I feel some trepidation in using the penis as a generic character of so much importance, as little is known concerning its value.

Type of the genus.—*Ischnura denticollis* (Burmeister).²

The name proposed is suggested by the black dorsum of the abdomen; *κελαινός* = black; *οὐρά* = tail.

6. A NEW SPECIES OF CELAENURA, WITH NOTES ON C. DENTICOLLIS AND ITS NYMPH.

In May, 1914, I found among some specimens of *Celaenura denticollis*, which were collected on Sharon Pond a mile west of Stanford University campus, a single male of coloration similar to *denticollis* but with very different appendages. Though I collected some hundreds of *denticollis* in various parts of California and Nevada during 1915 and 1916, only three more specimens of this new species were taken. These were caught on Coyote Creek, in the city of San Jose,

¹ Kirby, W. F. A Synonymic Catalogue of Neuroptera Odonata, or Dragonflies, 1890, p. 147.

² It is possible that the type, a female in the museum of Halle, may be the female of the species we now know as *damula*. The female of *damula* has been discovered recently and has a prothorax very similar to that figured by Calvert for the type-specimen of *denticollis*, in Halle (Trans. Amer. Ent. Soc., vol. 26, 1898, p. 38).

Santa Clara County, California, on May 15, 1915. Sharon Pond is an artificial pool 200 feet long and 3 feet deep on the estate of the same name west of Stanford. The single male was collected by sweeping in the sedges growing about its borders. The three specimens from San Jose were collected in the sedges along the edge of Coyote Creek, which at this season is a sluggish and almost stagnant stream. I have no data that would indicate that the habitat and habits of this species differ from those of *denticollis*, except that this has been found in only the two places mentioned, while *denticollis* is found throughout the southwestern States and northwestern Mexico. A fuller discussion of Coyote Creek and its odonate fauna is given on page 596 of this paper. The following is a description of this species:

CELAENURA GEMINA, new species.

This is a small species with coloration almost identical with that of *denticollis*. (See figs. 53-55 and compare with figs. 56-58.)

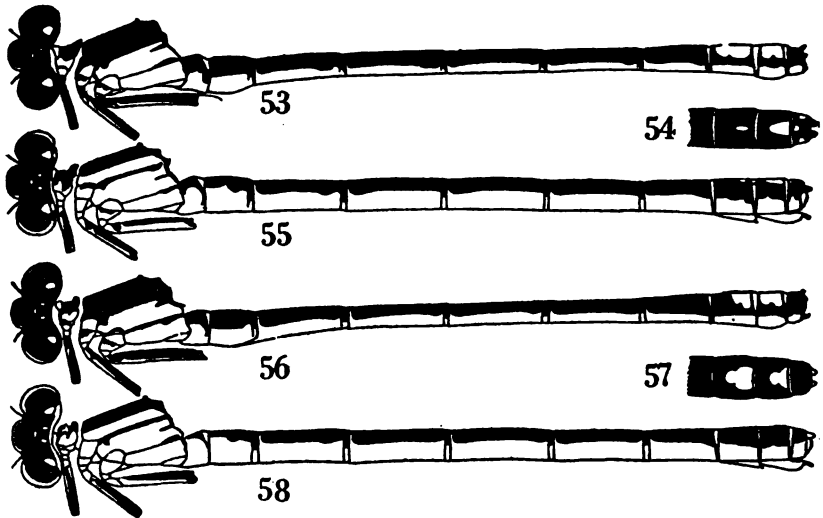
Type.—Cat. No. 20816, U.S.N.M. A male, from Coyote Creek, San Jose, Santa Clara County, California, May 15, 1915.

Allotype.—Cat. No. 20816, U.S.N.M. A female, from Coyote Creek, San Jose, Santa Clara County, California, May 15, 1915, taken in copulation with the type.

Length of abdomen: Male, type, 19 mm.; of the remaining two, one measures 19, the other 22 mm.; female, allotype, 21. Length of hind wings: Male, type, 14 mm.; of the remaining males, one measures 15, the other 16; female, allotype, 17.

Male structure.—As compared with other species of this group (*Ceratura*, *Anomalagrion* and *Ischnura*) this, for its size, is fairly robust. Head with shallow antennal fossae and a prominent occipital ridge. Prothorax with the posterior lobe half the length of the middle lobe and slanting caudad and dorsad at an angle of 45°. This lobe is thin antero-posteriorly and viewed from in front slightly concave on each lateral edge, but evenly convex on the posterior edge. A tuft of long hairs on each outer end of the middle lobe. Femur of front leg with a single internal basal spine, a single internal apical spine and 5-6 external spines; femur of the middle leg with 8 internal and 8 external spines; of the hind leg with 12 internal and 10 external spines. Tibia of fore leg with 2 spines above the comb and 2 below and 8 internal spines; of middle leg with 13 internal and 8 external spines; of hind leg with 18 internal and 11 external spines. Hind femur reaching to second third of segment 2. A large, hairy, hemispherical tubercle on the ventral side of the metathorax. Wings extending to apex of segment 6, with rhomboidal stigmas, those of the fore wing black, of hind wing brown. Penis of the two-horned ischnuran type but without the pair of large internal spines (fig. 92). The terminal processes ("horns") one-half longer than in *denticollis*; two minute

spines on each side of the apex of the shaft. Posterior hamules twice as long as wide, tips rounded and barely reaching the edge of the sexual fossa. A short but distinct spine on antero-ventral edge of segment 3 next the seminal vesicle. Segment 10 with a narrow, high, forked, dorso-apical projection (see figs. 94-96). Superior appendage, viewed from the side, with a conical base from the ventral side of which a long, basal, pointed branch extends ventrad and behind the upturned dorsal branch of the inferior appendage. Viewed from the side the inferior appendage very short, the inferior branch merely a rounded tubercle, the superior branch short, turned up and covering



FIGS. 53-55.—*CELAENURA GEMINA*. 53. MALE COLOR PATTERN. 54-55. FEMALE COLOR PATTERN.
FIGS. 56-58.—*CELAENURA DENTICOLLIS*. 56. MALE COLOR PATTERN. 57-58. FEMALE COLOR PATTERN.

the inferior branch of the superior appendage. Viewed from above the superior appendages are sigmoid-conical and diverge widely from the median line.

Female, structure.—Differing from male as follows: Prothorax with posterior lobe divided by two notches in its posterior edge into a median and two lesser lateral portions. Viewed from side the posterior edge of hind lobe presents two concavities, one from base to lateral notch and one between notch and apex (see figs. 62, A-B). (Mesostigmal lamina, fig. 93.) A minute spine on apex of ventrum of segment 8. Segment 10 three-fifths as long as 9. Superior appendages two-thirds as long as segment 10, ends obtuse. Genital valve reaching almost to apex of segment 10, its ventral edge smooth but covered with short hairs. Palp two-thirds length of 10.

Male, color.—Labrum, bases of mandibles and genae bluish green. Base of labrum edged with black. Nasus blue, postclypeus black. Frons blue on vertical surface, its dorsal surface black, which is con-

tinuous with the black of the vertex. Postocular spots blue, minute, not connected. Eyes with the ventral three-fourths blue, which is sharply separated by a horizontal line from the black dorsal fourth. Rear of head blue. (See fig. 53.)

Prothorax black, except anterior lobe, which is pale, and the side of the middle lobe, which is blue.

Mesothorax and metathorax black dorsally, the black extending caudad halfway to the first lateral suture. Upper half of mesinfracristernum black. Second lateral suture narrowly black except on its upper third where the black stripe dilates into an elliptical mark. Sides otherwise blue. Coxae greenish blue with a black stripe across the external face. Trochanters and femora black with the inferior side yellowish green. Tibia yellow with an external, black stripe. Tarsi yellow. Stigmas of the front wings black, of the hind wings brown.

Abdomen with the lower sides of segments 1 and 2, the basal half of the side of segment 3 and the lower sides of segments 8-10 blue. The dorsum of segments 1-7 and 10 broadly black, except a narrow, pale basal ring, interrupted on the middorsal line, excepting also the apex of segment 1, which is blue, and the blue dorsum of segments 8 and 9. Sides of segments 4-7 creamy.

Female, color.—Similar to that of the male but with a broad, pale, antehumeral stripe. (See figs. 54-55.)

Labrum yellow, edged above with black. Nasus, genae, bases of mandibles and anterior surface of frons yellow. Postclypeus, dorsal surface of frons and vertex black. Occiput edged with yellow. Postocular spots larger than in the male, not connected with each other but confluent posteriorly with the pale brownish of the rear of the head. Eyes greenish, darker above.

Prothorax black on the dorsal surface, except the anterior lobe pale and the pale olive of the sides extending up farther than in the male.

Mesothorax and metathorax olive on the sides, shading into creamy on the coxae and into brown on the antehumeral stripe. The black confined to the mesepisterna, a spot on the dorsal edge of the mesinfracristernum and a small spot on the upper end of the second lateral suture. A brown antehumeral stripe one-third as wide as mesepisternum. Trochanters and legs creamy, with a broad black stripe on the dorsal surface of the femur and a narrow external stripe on the tibia. Feet pale. Wings with brown stigmas.

Abdomen broadly black above except the apex of segment 1, a minute middorsal spot on segment 8, a large apical middorsal spot on 9 and a minute, basal, middorsal spot on 10, blue. Segments 3-7 with a narrow basal pale ring interrupted on the middorsal line. Intersegmental membranes of segments 2-7 black; of segments 1-2 and 7-10 blue. Lower sides of segments 1-10 pale creamy yellow.

This pair, the type and allotype, are dried alcoholics. My memory is that in life the female had the pale colors on the thorax and abdomen pale green.

CELAENURA DENTICOLLIS (Burmester).

This smallest of western dragonflies occurs throughout the warmer valleys of California, Nevada, Arizona, and northwestern Mexico. My data for Mexico are from Calvert.¹ This species is found commonly on the high central plateau of Mexico, where the farthest south record is on the slope of Mount Orizaba at an elevation of over 6,000 feet. It does not occur on the lower land of the east coast but it is found down the west coast, although not as far south as it occurs on the cooler plateau. In California and Nevada it is found from sea level up to 4,400 feet. It is, in the latter States, distinctly a spring stream species, though in southern California it is found about almost any permanent, sluggish water. Many of my northern records are spring-stream records. In the hot Sacramento Valley I found it at Colusa, which was as far north as I went. At Calistoga, California, it was very abundant in the cooler of the warm outlets of the Hot Springs. It occurred in a spring stream at Auburn, California (3,400 feet elevation), on the east side of the Sacramento Valley. At Golconda, Nevada (elevation, 4,400 feet), perhaps the coolest climate in which I found it, *denticollis* flourished in a warm spring where freezing weather could have little influence on the nymphs. In none of the localities mentioned in the preceding, with the exception of Golconda, Nevada, where the nymphs are protected from the freezing weather by the warm water, are there heavy frosts with any severe winter weather.

Its distribution then indicates that it is distinctly a subtropical insect, but just as distinctly that it is not tropical. It is with equal distinctness confined to the semiarid and arid regions. This interesting distribution from sea level on the northern boundary of its habitat to the great elevation on its southern boundary is found in many other western Odonata, many species having very definite temperature limits.

The habits of this species are in general ischnuran but indicate greater feebleness. Early in the morning it is found in the sedges and grasses bordering the water but during the heat of the day it spends the greater part of its time over the surface of the water, usually seated on trash or aquatic vegetation. At Calistoga I had an excellent opportunity of observing its habits because of its great abundance.

Here several nymphs ready to transform were taken from the trash around the edge of a warm spring and the exuviae were common on the grass stalks fringing the water. I caught none in the act of transforming, as it was cold rainy weather, but I feel reasonably certain of the identity of these nymphs.

¹ Biol. Amer., Neur., pp. 126, 337.

The females resorted to the little drain ditches to oviposit; there the males in great numbers awaited their coming. After a considerable time in copulation, seated on some grass stem the female, still accompanied by the male, would fly to the surface of the stream, preferably a quiet lateral pool, and commence ovipositing.

In ovipositing the male held the female by the head.

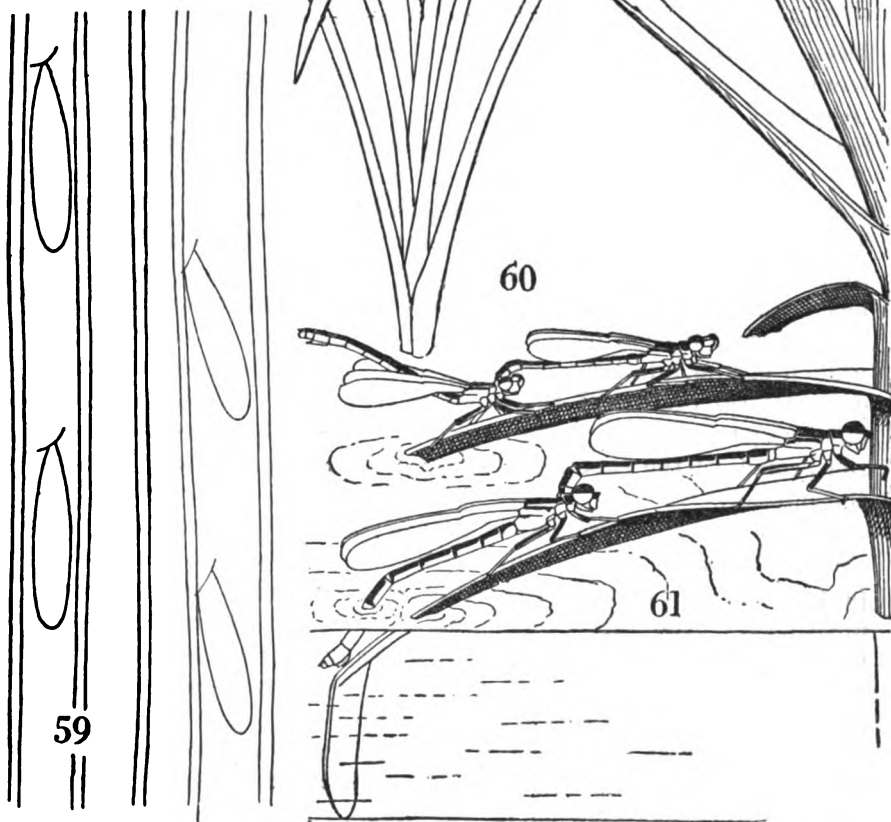


FIG. 59.—*CELAENURA DENTICOLLIS*, PAIRS OF EGGS IN TISSUE OF GRASS LEAF.

FIGS. 60-61.—*CELAENURA DENTICOLLIS*. 60. PAIR RESTING BETWEEN OVIPOSITIONS, FEMALE WITH ABDOMEN RAISED. 61. FEMALE OVIPOSITING.

The pair would alight on floating vegetation, in a horizontal position, and the female would bend her abdomen slightly and make usually one or two incisions, after which she would raise the end of her abdomen con-

siderably above the horizontal and wait in this position several seconds, when the pair would fly to another straw and repeat the one or two thrusts followed by the wait with the tip of the female's abdomen in the air. (See figs. 60-61.) This was kept up, by a pair under observation, for 20 minutes. In no place did they make more than one or two thrusts. Further, I was not positive at the time that the ovipositor was actually thrust into the plant tissue, as the females observed put forth none of that painstaking effort usually shown by ovipositing dragonflies. Later, when these grass blades were examined in the laboratory, eggs were found in pairs (see fig. 59). This species is undoubtedly the feeblest of all the western Odonata, not excepting *Telabasis salva*, which is no larger but much more active.

Length of abdomen: Male, 19 mm.; female, 20. Length of hind wings: Male, 12 mm.; female, 14.

Male, structure.—Only 2 internal spines on anterior femur, one at base, the other at apex. Hind tibia with 6 external spines. Hind femur reaching to middle of segment 2. Wings reaching to middle of segment 6. A low hairy prominence on ventral side of metathorax. Segment 3 with a low spine at anterior ventral angle of side. Penis (fig. 85) two-horned as in *Ischnura* but without the pair of erect spines on the ventral side of the penultimate segment. The fleshy tips but two-thirds as long as in *gemina*. Segment 10 with a raised forked process on the middorsal apex. Appendages of segment 10 (figs. 89-91) similar to those of *gemina* with the following differences: The external branch of the superiors wanting; the inferior-external branch of the inferiors developed into a short upturned hook; the dorso-lateral branch of the inferiors very short. In *denticollis* the inferiors project beyond the superiors. In *gemina* (fig. 95) the inferior branch of the superior falls anterior to the superior process of the inferior.

Female, structure.—Similar to that of male except as follows: Prothorax with the dorsum of the middle lobe with a pair of low conical protuberances or horns. The posterior lobe rounded and moderately developed. (The only female with which *denticollis* might be confused is that of *damula*, which has the same two horns but the posterior lobe is reduced to a large tubercle projecting caudad.) (See figs. 63, A-B.) (Mesotigmal laminae, fig. 88.)

Anterior femora with but two internal spines, one at base and one at apex. Posterior femora reaching to middle of segment 2. Wings reaching to base of segment 7. Segment 10 half as long as 9; appendages two-thirds length of 10. Segment 8 with minute spine.¹ Genital valve reaching to apex of 10, and minutely serrate along its ventral margin. Palp two-thirds length of 10.

¹ Calvert has shown that as many as 80 per cent of the females from a locality may not possess this spine. Biol. Cent. Amer., Neur., pp. 126, 387.

Male, color.—Labrum pale, nasus pale, edged above with black, postclypeus black. Genae, bases of mandibles and anterior surface of frons greenish blue. Vertex black. Postocular spots small, pure blue, not connected, and not confluent with the blue of the rear of the head. Eyes greenish below, abruptly black above. Rear of head blue, with a large, central, black spot. (See fig. 56.)

Prothorax shining greenish black, except anterior lobe, pale, and lower half of side, pale blue. Coxa blue.

Mesothorax and metathorax greenish blue, with the anterior surface black, this extending caudad along the sides to halfway between the humeral and first lateral sutures. Mesinfraepisternum blue, its upper third black. Second lateral suture narrowly black, this widening above into a narrow elliptical spot. Coxae blue with a black spot. Legs: Trochanters and femora black with a broad blue stripe on the interior side; tibiae greenish with an external black stripe; feet pale. Stigmas of front wings black with white apices; hind wings brown with white apices.

Abdomen shining black, except as follows: Side of segments 1, 2, the anterior two-thirds of side of 3, sides of 8–10, blue. Also apex of 2 blue; a trifoliate pure blue spot on apex of dorsum of 8, as well as the dorsum of 9 blue. Sides of segments 4–7 yellow. Segments 3–7 with a narrow, pale, basal ring, interrupted middorsally. Intersegmental membranes of segments 8–10 pale.

Female, usual adult color.—Labrum greenish, edged above with black; nasus, base of mandibles, genae and anterior surface of frons bluish green; postclypeus and vertex black. Postocular spots moderate, blue, and confluent with the greenish blue of the rear of the head. Eyes greenish below, with a black cap, sharply demarked by a horizontal line. (See figs. 57–58.)

Prothorax bluish green on the sides, its dorsum black, except the anterior lobe and the two horns, usually pale.

Mesothorax and metathorax blue, except for the following black markings: A broad middorsal stripe occupying half of the mesepisternum on either side, a narrow humeral stripe and narrow stripes on the upper fourth of the first and second lateral sutures. Legs greenish with the femur broadly black above and the tibia with an external black stripe; feet pale. Pterostigmas brown.

Abdomen with entire dorsum black, except a narrow basal pale ring, interrupted middorsally on segments 3–7, and the intersegmental membranes of segments 1–2 and 7–10, which are blue. Sides of segments 1, 2, and 8–10 blue, of 3–7 yellow.

The female of this species from the teneral to the senile color passes through several remarkable color stages, and is dimorphic and possibly trimorphic in color. The large series of females collected at Calistoga, California, June, 1914, were studied as to their color patterns

with the following results, which are transcribed from notes taken at the time.

Color No. I, *teneral on emerging*.

Face pale luteous, the vertex and dorsal surface of frons dark gray; postocular spots large, broadly connected and of the same luteous tint as the rear of the head. Eyes pale green, with no dark cap.

Thorax pale luteous (straw color), with broad middorsal and narrow humeral stripes, which are dark gray. Legs straw color, with a faint external dark stripe on the tibia; feet greenish.

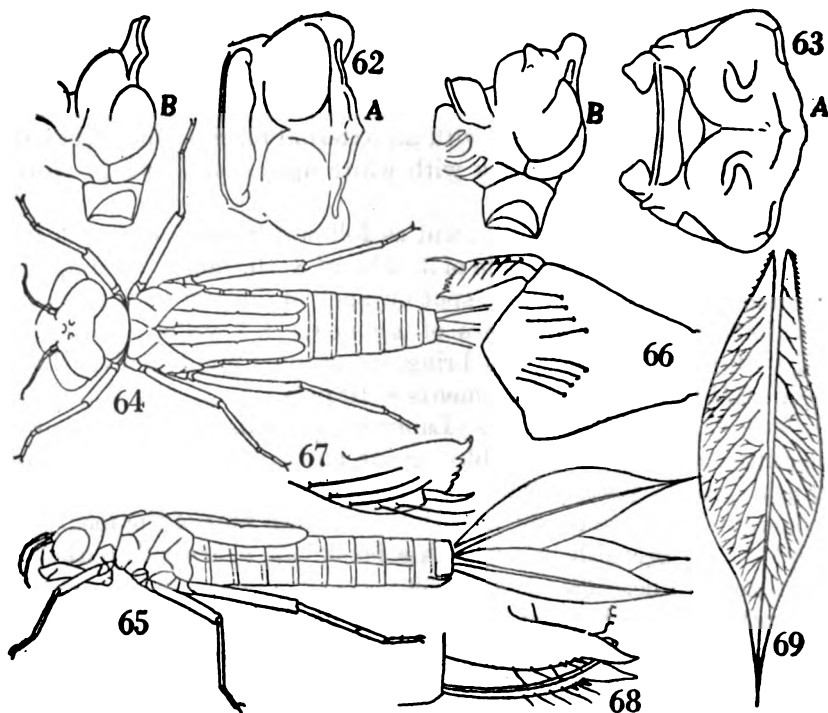


FIG. 62, A AND B.—*CELAENURA GEMINA*, FEMALE PROTHORAX.

FIGS. 63-69.—*CELAENURA DENTICOLLIS*. 63, A AND B. FEMALE PROTHORAX. 64-69. NYMPH. 65. MESOTUM. 67. MENTAL LOBE. 68. SEGMENT 9 OF FEMALE. 69. CAUDAL GILL.

Abdomen with sides straw colored and dorsum gray, except a broad straw dorsal spot on segments 8 and 9, this spot interrupted on base of 9 in some females.

This extreme teneral phase rapidly changes into the following:

Color No. II. Black pattern as in No. I, but face, postocular spots, sides of thorax, legs, sides of 1 and 2 and dorsum of 8 and 9 pink. This changes into:

Color No. III. Black pattern as in Nos. I and II; pale colors as in No. II, but postocular spots reddish, sides of 3-7 yellow; dorsum of 8 and 9 blue. This changes to:

Color No. IV. Postocular spots blue, legs still pink; thorax, sides of 1 and 2 and dorsum of 8 and 9 blue. Sides of 3-7 yellow. In this stage the postocular spots have become disconnected and much reduced in size. The eyes previous to this stage have been pale green, lighter below, but now the black cap is sharply indicated. The black humeral line has become broader; the external line on the tibia is heavier and an external line is appearing on the femur. This changes into:

Color No. V. This is close to the "adult" stage described first. In this final stage the postocular spots are becoming obscured by smoky, the humeral line has widened until it has obliterated the pale antehumeral line, the blue spots on dorsum of 8 and 9 have been replaced by black and the femora have become broadly black above.

This final stage seems to be dimorphic, as some old females have the pale areas green and some pure blue. Among the 75 *Calistoga* females I saw but two green females.

Dr. Calvert¹ described a yellow form of the female of this species. As he had dried material only, it is possible that his yellow form is the same as this green form with the blue factor of the green faded. Some agrionines, greenish blue in life, fade to yellow in dried material.

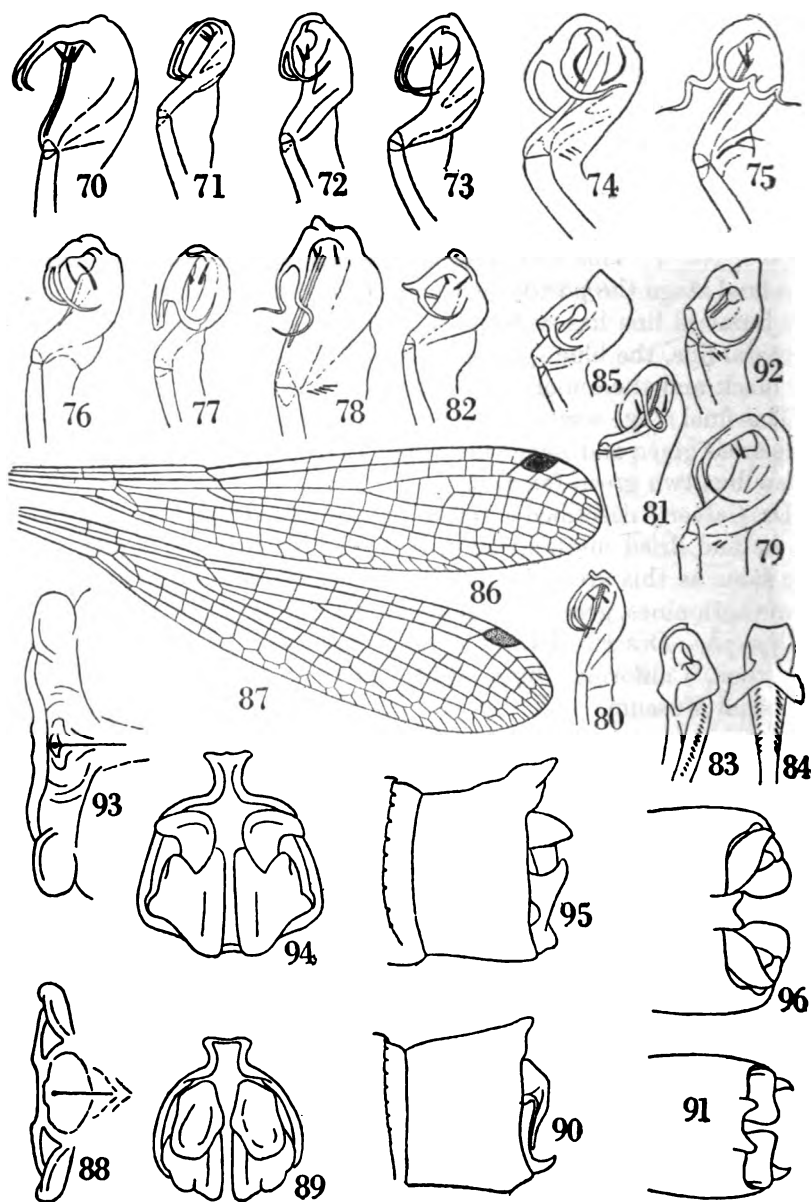
Nymph.—Described from a male nymph (alcoholic) collected at *Calistoga*, California, June, 1914. Deposited in the United States National Museum.

Abdomen (exclusive of gills), 6 mm.; gills, 5.5; hind femur, 3; head, 3 mm. wide.

Nymph (see figs. 64-69) of the usual *ischnuran* form with wide flat head, short abdomen, long legs and acuminate gills. Antenna seven jointed. Labium with four mental setae on each side and a row of five setae on the lateral lobe. Wings reaching to the middle of segment 4. Hind femora reaching to middle of segment 4. The abdomen tapering regularly to apex, with a well-defined lateral keel on segments 1-8. Genital valves of female reaching to beyond apex of 10; the ventral edge with two small spines and several long hairs. Gills widening to the apical two-fifths, whence they taper to an acuminate point. The inferior edge of the gill is straight from the base with but slight taper for the first third, when the widening of the gill increases rapidly to the apical two-fifths, as stated previously. This first straight third of the interior edge is heavily spiculed while the remaining portions of the superior and inferior edges are smooth, except 8 widely spaced spicules on the base of the dorsal edge (see fig. 69).

The colors in this nymph were inconspicuous. This peculiar restriction of the spicules to the base of the gills distinguishes this nymph from those of *Ischnura cervula* and *I. perparva*, in both of which both edges of the gills are spiculate to beyond the middle. In both

¹ Biol. Cent. Amer., Neur., p. 127.



FIGS. 70-81.—*ISCHNURA* PENES. 70. *I. PERPARVA*. 71. *I. DEMORSA*. 72. *I. VERTICALIS*. 73. *I. DAMULA*. 74. *I. ERRATICA*. 75. *I. RAMBURNI CREDULA*. 76. *I. KELICOTTI*. 77. *I. BARBERI*. 78. *I. KLEGANS*. 79. *I. CERVULA*. 80. *I. POSITA*. 81. *I. PUMILIO* (GENOTYPE).

FIG. 82.—*CERATURA CAPRIOLA*, PENIS.

FIGS. 83-84.—*NEHALENNIA IRENE*, PENIS.

FIGS. 85-91.—*CELAENURA DENTICOLLIS*. 85. PENIS. 86-87. WINGS. 88. FEMALE, MESOSTIGMAL LAMINAE. 89-91. MALE, SEGMENT 10.

FIGS. 92-96.—*CELAENURA GEMINA*. 92. PENIS. 93. FEMALE, MESOSTIGMAL LAMINAE. 94-96. MALE, SEGMENT 10.

of these the spiculation weakens gradually caudad, while in this *denticollis* nymph it is strong and ends abruptly at the apical end of the straight basal section of the inferior edge.

7. A NEW GENUS BASED ON TACHOPTERYX HAGENI.

While labeling the dragonflies in the collection of the California Academy of Science it was my good fortune to find a pair of the very rare *Tachopteryx hageni* Selys. With the permission of the director, Dr. Barton W. Evermann, I had the privilege of bringing these specimens to Stanford, where I was able to make a careful study of them.

Tachopteryx Selys is, perhaps, the most primitive genus of living anisopterous dragonflies in North America. Only three species are known: *Tachopteryx pryeri* Selys from Japan, *Tachopteryx thoreyi* (Hagen) from the Alleghanies of eastern North America, and *Tachopteryx hageni* Selys, which was described in 1879 from a single male specimen collected in "Nevada" and now in the Selys collection in Brussels.

In September I had the privilege of working in Mr. Williamson's collection at Bluffton, where studies of *thoreyi* were made. Through the kindness of Mr. Williamson and Doctor Ris I was enabled to get into touch with MM. Severin and Meuninger, who have forwarded photos and drawings of *pryeri*. At about the time of the arrival of these figures my attention was called by Doctor Calvert to three very fine specimens of *pryeri* in his collection in the Philadelphia Academy of Science. These I had the privilege of studying while working in this collection recently. Further, Mr. Williamson has loaned me the original of his published drawing of the nymph of *thoreyi*.

From my study and comparison of this data I believe that the two species *hageni* and *pryeri* should be placed in a genus distinct from *Tachopteryx thoreyi*, as the latter shows structural characters and a higher development of the venation which separate it from *hageni* and *pryeri*.

TANYPTERYX, new genus.

Of the Petalurinae. Eyes widely separated, labium with median lobe cleft. Whip of antenna jointed. The internal triangle of the front wings three celled, its sides subequal. Superior appendages of the male only moderately dilated. A large hairy tubercle on the ventral side of the metathorax. Color largely black.

Wings with normally a more reduced venation than in *Tachopteryx thoreyi*. The third, fourth, or rarely fifth antenodal developed as a brace vein. The anal loop with two to four cells. (This varies in some wings, for the female *hageni* in Philadelphia has five in one

wing and the female *pryeri* in the same collection has six in the left and seven in the right hind wing.) Anal vein of hind wings with four to six branches. (See figs. 126-129.)

Type of the genus.—*Tachopteryx hageni* Selys. This genus contains also *Tachopteryx pryeri* Selys of Japan.

The name proposed is from the Greek: *ταχυπτερυξ* = swift-winged.

The erection of this genus leaves in *Tachopteryx* Selys only the species *thoreyi*, which occurs in the Appalachian Mountains of the eastern United States. The genus *Tachopteryx* may then be described in its restricted sense as follows:

TACHOPTERYX Selys, restricted.

Of the Petalurinae. Eyes widely separated. Labium with median lobe cleft. Whip of antenna jointed. The internal triangle of the front wings three celled, its sides subequal. Superior appendages of the male only moderately dilated. No large tubercle on ventral side of metathorax.¹¹ Color largely yellowish olive.

Wings with a richer venation than in *Tanypteryx*. The sixth or seventh antenodal developed as a brace vein. The anal loop with five to seven cells. The anal vein of hind wings with six to eight branches. (See figs. 130-132.)

Type of the genus.—*Tachopteryx thoreyi* Selys.

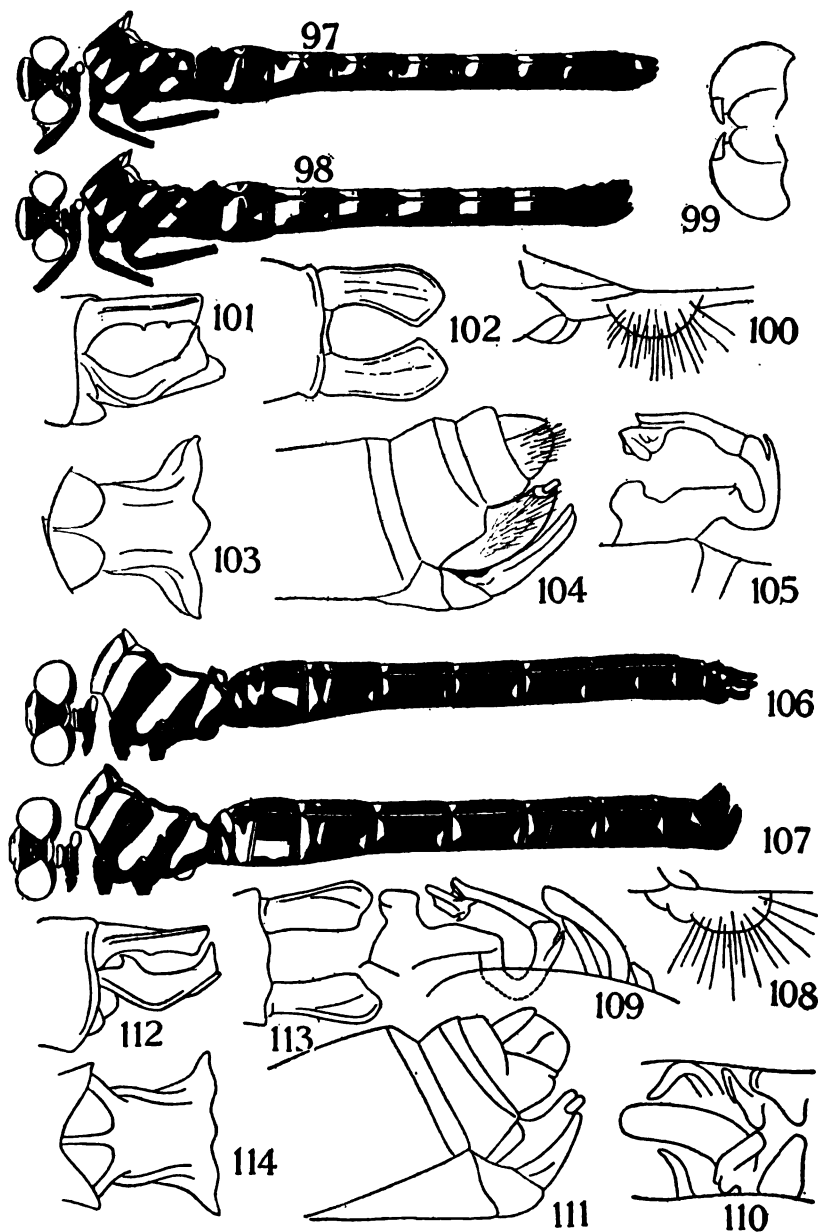
TANYPTERYX HAGENI (Selys).

Tanypteryx hageni has not been recorded since the original specimen was described by Selys. The two specimens in the California Academy of Science collection were taken by Prof. E. C. Van Dyke, at Monroe, Washington, in July, 1915. The eastern *Tachopteryx thoreyi* inhabits mountain swamps and bogs. As Monroe, Washington, is on the west side of the Cascades where there is a very long rainy season, probably *Tanypteryx* inhabits similar situations there, and with a step further one can infer that the type-specimen collected in "Nevada" came from some high mountain swamp.

A teneral female of *Tanypteryx hageni* is preserved in the Philadelphia Academy of Science. This was collected in California, probably by Behrens, in Shasta County. One other specimen is in the Museum of Comparative Zoölogy. This is from Reno, Nevada, collected by Morrison in 1878.

The following is a description of the two specimens in the Museum of the California Academy of Science:

Color of male.—Face dark brown except a yellow spot at base of each mandible (the "dark brown" of this species approaches black, only a close examination showing that it is not true black). Frons yellow, excepting a small brown area on each side below and a narrow brown band across its posterior edge. Vertex dark brown.



FIGS. 97-105.—*TANYPTERYX HAGENI*. 97-98. COLOR PATTERN. 99. LABIUM. 100. METATHORACIC TUBERCLE. 101-103. MALE, APPENDAGES. 104. FEMALE, SEGMENTS 9 AND 10. 105. PENIS.
FIGS. 106-114.—*TANYPTERYX PETERSI*. 106-107. COLOR PATTERN. 108. METATHORACIC TUBERCLE. 109. PENIS. 110. HAMULUS. 111. SEGMENTS 9 AND 10 OF FEMALE. 112-114. MALE, APPENDAGES.

Occiput brown with twin yellow spots on its posterior surface. The posterior surface of the head black. Labium pale brown. (See fig. 97.)

Prothorax dark brown with a pale yellow spot on each side of the posterior lobe and a pair of minute yellow spots just posterior to the anterior lobe, also a yellow spot on each coxa and a smaller spot just above each coxa. Front legs black with a yellow stripe occupying the middle two-fourths of the ventral (internal) face of the femur.

Mesothorax and metathorax dark brown with the following yellow spots: A triangular spot on the lower half of each mesepisternum, a minute spot above this just below the antealar sinus, a second minute spot in the antealar sinus. The sides of the thorax with four large spots arranged in pairs obliquely; the anterior pair on the mesepimeron, one in the lower anterior angle and its mate in the upper posterior angle with a third and minute spot in the upper anterior angle. The posterior pair of lateral spots are on the metepimeron, the lower spot in the center of the lower end and the upper in the center of the upper end. Also a minute spot in the upper end of the metepisternum. Coxae and middle and hind legs black. Wings with a brownish tinge.

Abdomen black with orange markings. Segment 1 with a brown transverse dorsal band on its apex. Segment 2 with an anterior S-shaped spot on each side and a minute spot on each side of the apical end. Segment 3 with a wide V-shaped anterior spot on each side followed by a minute spot just posterior to the vertical carina. Segments 4 and 5 with the V spot broken into a minute anterior arm and a large posterior arm which lies just anterior to the vertical carina. A small dorsal spot just posterior to the vertical carina and a small latero-apical spot. Segments 6 and 7 marked as are 5 and 6, except that the latero-apical spot is wanting on both segments and the minute anterior spot is wanting on 7. Segment 8 with only a large antero-lateral spot representing the posterior arm of the V in the anterior segments. Segments 9 and 10 black, but the intersegmental membrane of 8-9-10 pale brown. Appendages black.

Color of female.—Female colored as in the male, except that the V spots of the male abdomen are represented on segments 2 to 7 by a rectangle of orange occupying almost the entire space from the anterior end of the segment to the vertical carina and from the middorsal line to the middle of the side. Segments 2-4 each with a pair of minute dorsal spots just posterior to the vertical carinas, and a latero-apical spot on each side. Segments 8-10 black, except the intersegmental membranes of 7-10, which are pale brown. (See fig. 98.)

Male abdomen, 44 mm.; hind wing, 34. Female abdomen, 42 mm.; hind wing, 36.

Structurally this species is characterized by its small size, the hairy tubercle on the ventral side of the metathorax, the superior appen-

dages of the male with three minute teeth along their lower edge, the inferior appendage with a large midapical lobe and lacking the pair of superior basal hooks found in *thoreyi* and *pryeri*. The stylus in the female is placed at the apex of the genital valve. (See figs. 99–105.)

TANYPTERYX PRYERI (Setya).

This interesting species is found in Japan, and like a number of other species finds its nearest relative on the Pacific slope of North America. The wings reproduced in the accompanying illustrations (figs. 124–125) are traced from photographs made in Brussels, while the remainder of the illustrations of *pryeri* are from the specimens in the Philadelphia Academy of Science.

The following is a description of these specimens.

Color of male.—Black and yellow with the general appearance of *hageni*.

Labium black. Face black, except a small yellow spot on base of mandible. Frons yellow, except on its posterior edge. The yellow of the frons extends down in front over the dorsal fourth of the middle two-fourths of the nasus. Vertex black. Occiput black on the anterior surface, yellow on the posterior surface. Posterior surface of head black. (See fig. 106.)

Prothorax large, black, except its anterior lobe yellow, and a large yellow oval on each side of the posterior lobe.

Mesothorax and metathorax black, with the dorsal or inner half of each mesepisternum yellow as are also the anterior alar fossae. A large yellow area lying between the humeral and second lateral sutures; this extending dorsoventrad from just below the lateral alar ridge to below the spiracle; its upper edge paralleling the alar ridge, its ventral end rounded, its width approximately one-half the distance between the humeral and second sutures. A large triangular yellow area on the metepimeron. Infraepisterna, coxae and legs black. Pterostigmas brown.

Abdomen black with yellow as follows:

Segment 1 with a small dorso-lateral spot on each side of apex.

Segment 2 with an hourglass-shaped spot on each side above the auricle and anterior to the lateral vertical carina. A large wedge-shaped spot posterior to the vertical carina.

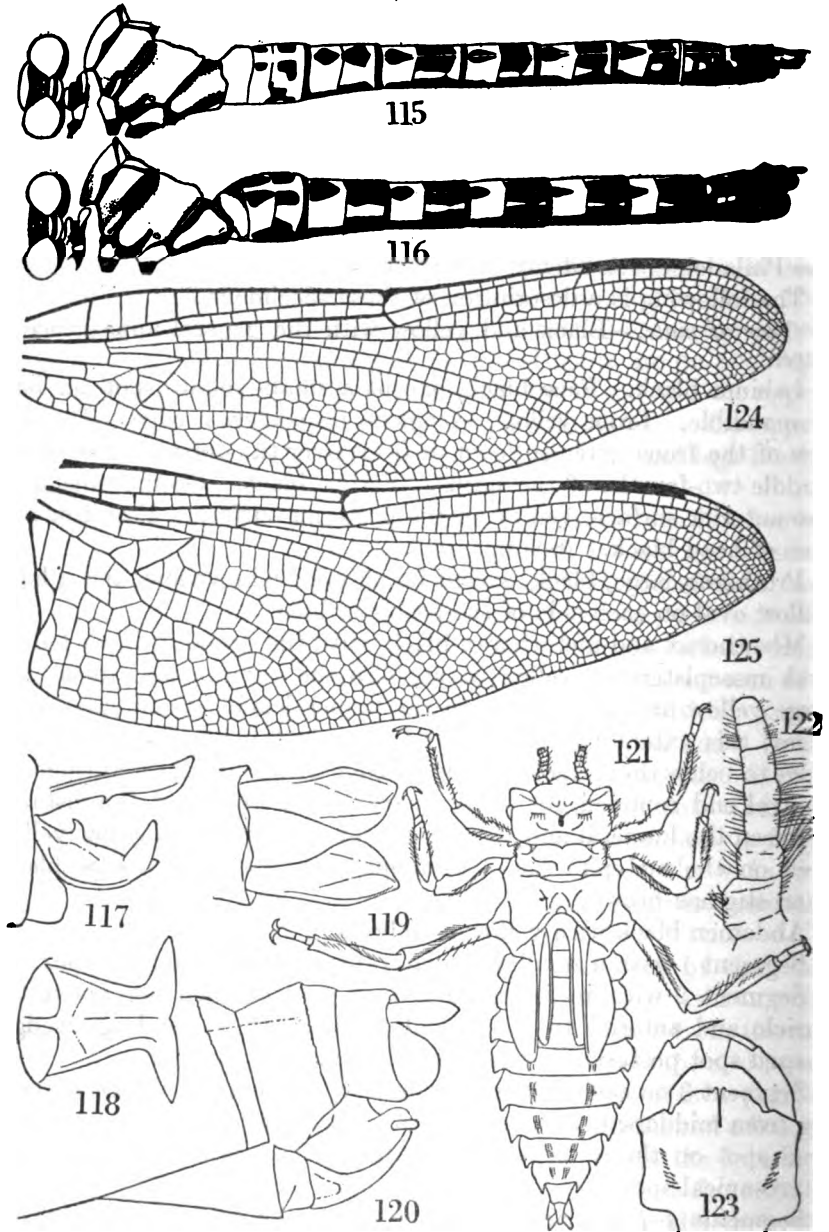
Segment 3 on each side with a narrow, vertical, basal spot extending from middorsal carina almost to lower edge of side, a narrow vertical spot on the anterior side of the vertical carina and a minute latero-apical spot.

Segments 4–7 similar to segment 3, but the spot anterior to the vertical carina lacking.

Segments 8 and 9 with the apical spots only.

Segment 10 with a minute spot in the center of the dorsal surface. Appendages black.

Color of female.—Similar to that of male, but—
Segment 1 with a dorso-apical spot as well as the two lateral apical spots. (See fig. 107.)



FIGS. 115-123.—*TACHOPTERYX THOREYI*. 115-116. COLOR PATTERN. 117-119. MALE, APPENDAGES. 120. SEGMENTS 9 AND 10 OF FEMALE. 121-123. NYMPH. 122. ANTENNA. 123. MENTUM.
FIGS. 124-125.—*TANYPTERYX PRYER*, WINGS.

Segment 2 with what was an hourglass-shaped spot above the auricle in the male, in the female a large yellow area extending ventrad

almost to the lower edge of the side. The lateral apical wedge in the male represented by a broad lateral stripe extending from the vertical carina to the apex of the segment.

Segments 3-8 as in the male.

Segments 9 and 10 black, as are the appendages.

The measurements of the three Philadelphia specimens are as follows:

No. 1, male, abdomen (incl. app.), 49 mm.; hind wing, 42.

No. 2, male, abdomen (incl. app.), 53 mm.; hind wing, 43.

No. 3, female, abdomen (incl. app.), 51 mm.; hind wing, 47.

Structurally this species is characterized by the following: A large hairy tubercle (fig. 108) on the ventral side of the metathorax, the male superior appendages with a low tubercle about midway of the edge, the inferior appendage with its lobes acute, widely spreading, but with merely a suggestion of a median terminal lobe (figs. 112-114.) (See also figs. 109-110, penis and hamules.) Female with the stylus of the genital valve arising below the apex (see fig. 111).

TACHOPTERYX THOREYI Setys.

The following summary of the habits of this species is from Mr. Williamson's published paper on the subject.

On June 4, 1900, Mr. D. A. Atkinson collected the only known nymph of this species in a boggy spot near Pittsburgh, Pennsylvania.

In the boggy spot, where the nymph was collected, at that time the only surface water was retained in small depressions, such as the tracks of cattle, among the roots of sedges and grasses. On July 15, 1900, Mr. J. L. Graf observed a female ovipositing in this same swale. She alighted among the dense grasses and placed the eggs among the roots or in wet decaying vegetable matter above the surface of the water. She would raise or lower her abdomen 8 or 10 times in one place, then fly to another spot. On June 23, 1900, Mr. Graf discovered another female ovipositing. A mere thread of water flowed from several small springs. The bed of this small stream was composed of cinders and sand. The dragon fly alighted in the grass near this stream and placed her eggs in a small depression in the cinders. This depression contained not more than a tablespoonful of water. Into this small basin she thrust her abdomen a number of times at the rate of 15 or 20 times a minute.¹

This same paper gives a very detailed description of the nymph mentioned previously. Mr. Williamson very kindly loaned me his drawing, which I have reproduced as figure 121.

In its heavy awkward shape the nymph is perhaps adapted to slow but powerful movements in bogs and mud. It is peculiar in its labium with the cleft median lobe and in the primitive, unspecialized form of the antenna (see figs. 122-123).

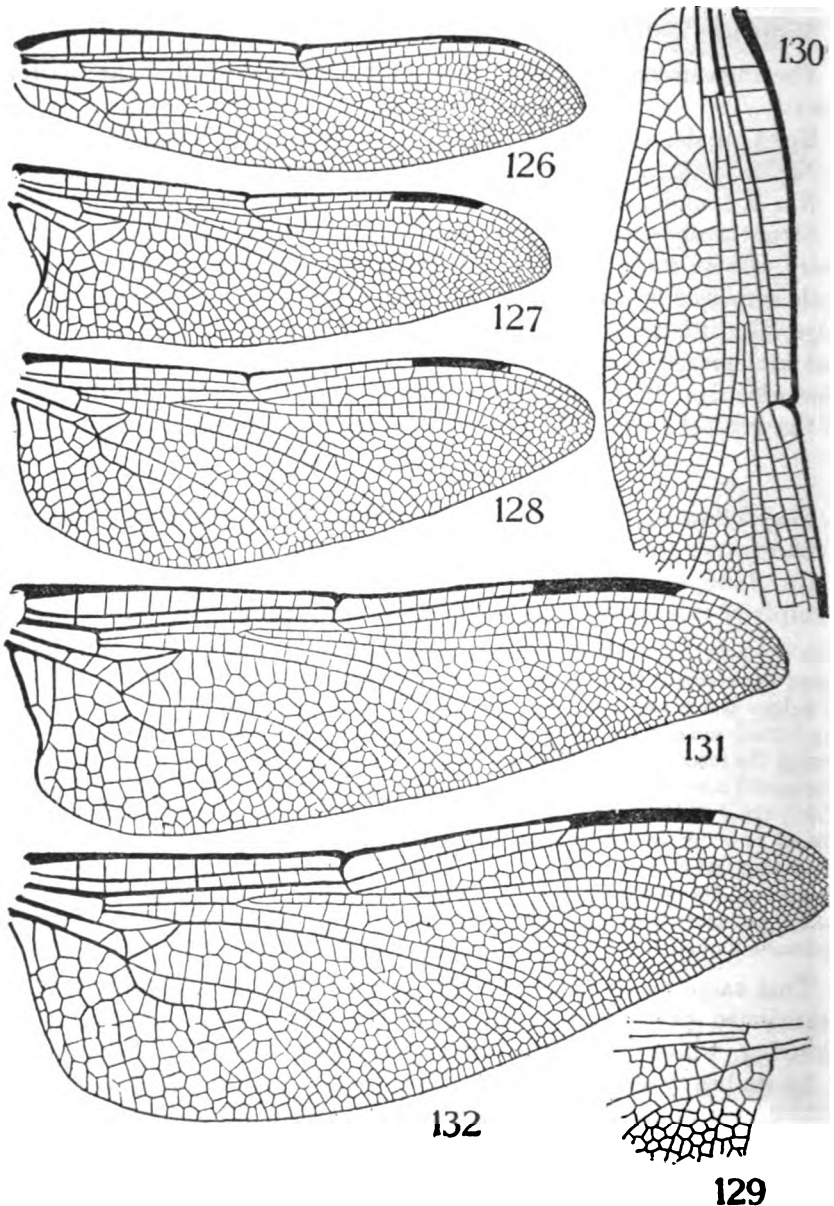
Prof. J. G. Needham² writes that this species has been taken from Massachusetts to Florida and Texas.

¹ Ent. News, vol. 12, 1901, pp. 1-3.

² Bull. 47, N. Y. State Mus., 1901, p. 472.

The following is a description of the color of *thoreyi*:

Male.—Labrum luteous, edged above and below with black, that above connecting with a circular median spot on the center of the



FIGS. 126-129.—*TANYPTERYX HAGENI*, WINGS.

FIGS. 130-132.—*TACHOPTERYX THOREYI*, WINGS.

labrum. Nasus black. Frons yellow, except the posterior edge of its horizontal surface which is edged with black. Vertex black.

Occiput yellow with a black band along its posterior edge. Posterior surface of head black. (See fig. 115.)

Prothorax black, its anterior and posterior lobes yellow. Proinfraepisternum pale.

Mesothorax and metathorax olive brown with dark brown, obscurely edged markings. Middorsal carina black. All alar ridges black. A broad band on humeral suture, a similar broad band on second lateral suture, and a third on the metasternal keel brown. Infraepisterna yellow. All coxae and legs black.

Abdomen with segment 1 pale.

Segment 2 yellow, with four dorsal black spots and a spot on each side posterior to the auricle.

Segment 3 yellow, with the lower edge of the side black and two tandem, lozenge-shaped, black spots on the middorsal line.

Segments 4 and 5 similar to 3 but with the posterior of the two dorsal spots expanded into a quadrilateral spot covering the entire dorsum posterior to the vertical carinae except a narrow band across the apex of the segment.

Segments 6 and 7 similar to 4 and 5 except in the greater extent of the post-dorsal spot which connects at its apex on each side with the black of the lower edge of the segment.

Segment 8 black except for a row of three small yellow spots on the upper part of each side.

Segment 9 with an irregular anterodorsal spot.

Segment 10 and appendages black.

Female.—Colored as the male but the black slightly more extensive (see fig. 116).

The upper end of the mesinfraepisternum black. The anterior edge and dorsum of segment 1 dark. The four dorsal spots on segment 2 and the lateral spot of the same segment larger. The postdorsal spot in segments 3 to 7 covering the entire dorsum posterior to the vertical carinae. Segment 9 as well as 10 entirely black.

Measurements: Male abdomen (incl. appendages), 55 mm.; hind wing, 50. Female abdomen, 57 mm.; hind wing, 50.

Structurally this species is peculiar in lacking the metathoracic tubercle found in *Tanypteryx*. In the male the superior appendage has a minute tooth on the middle of its inferior edge. The inferior appendage is without a median terminal lobe and has a pair of superior basal hooks. In the female the stylus is placed subapically on the genital valve. (See figs. 117-120.)

8. NOTES ON *CORDULEGASTER DORSALIS* AND *C. DIADEMA*.

The nine species of *Cordulegaster* known from North America are recorded from mountainous regions, though two are found also in the hillier areas of the northern Mississippi Valley. Six of these species occur in the Appalachians. Two are found in the mountains

of the Pacific slope while one other is recorded so far only from Mexico and Central America. The western species are *C. dorsalis* Hagen and *C. diadema* Selys. *Dorsalis* occurs in the coast mountains from Sitka, Alaska, south to the San Gabriel Mountains at Los Angeles, California. It is found up to an elevation of 4,000 feet on the west slope of the Sierras in California but has never been recorded from the eastern side of these mountains. *Diadema* is recorded from the mountains of Arizona and northern Mexico.

My records for *Cordulegaster dorsalis* are as follows: Stevens Creek, Santa Clara County, California, May 31, a single fresh exuvia and several grown nymphs were collected but no imagoes were seen; July 7, eight males were observed; August 16, three males and one female were caught, the latter while ovipositing. Zyante Creek, Santa Cruz County, California, July 9, numerous exuviae were found but no adults were seen. Napa Asylum Grounds, Napa County, California, June 8-9, six males were taken on a small mountain stream flowing from the Hospital reservoir; no females were seen. In Mr. Fordyce Grinnell, jr.'s, collection is a male taken on the Arroyo Seco at Pasadena, California, June 29, 1910.

The following records are from the west slope of the main Sierra Chain: On the American River at Auburn, Placer County, California, July 20, a single male was seen repeatedly at close range which had probably strayed from one of the small spring-fed side streams. In Bear Valley at Emigrant Gap, Placer County, California, a single male was taken July 21; two others were seen. This was at an elevation of 4,000 feet, the highest elevation at which this species is recorded, and is also the most eastern record, though it is still on the west slope of the Sierras.

Much that I shall write concerning *Cordulegaster dorsalis* will be almost a repetition of that concerning *Octogomphus*, as the habits and distribution of these in California are in many ways similar.

As far as I have observed, *C. dorsalis* is found usually on those swift mountain torrents which do not freeze in the winter time. There may be exceptions to this, as I took this species at an elevation of 4,000 feet in Bear Valley (Emigrant Gap, California), where there is a heavy winter snowfall and probably the streams freeze, though many of them are fed by numerous springs which may moderate their temperature. In the Coast Mountains of California, where it appears to reach its greatest numbers, it is found in the swift upper reaches of all the perennial streams. Here it is associated with *Octogomphus specularis*, *Aeshna walkeri*,¹ and *Argia vivida*, the last breeding in the springs of the mountain gorges. I have never seen or taken *Cordulegaster*, except in the steep canyons of the mountains. It does not occur on the lower reaches of these same streams after they have emerged onto the level valley floors and have lost their

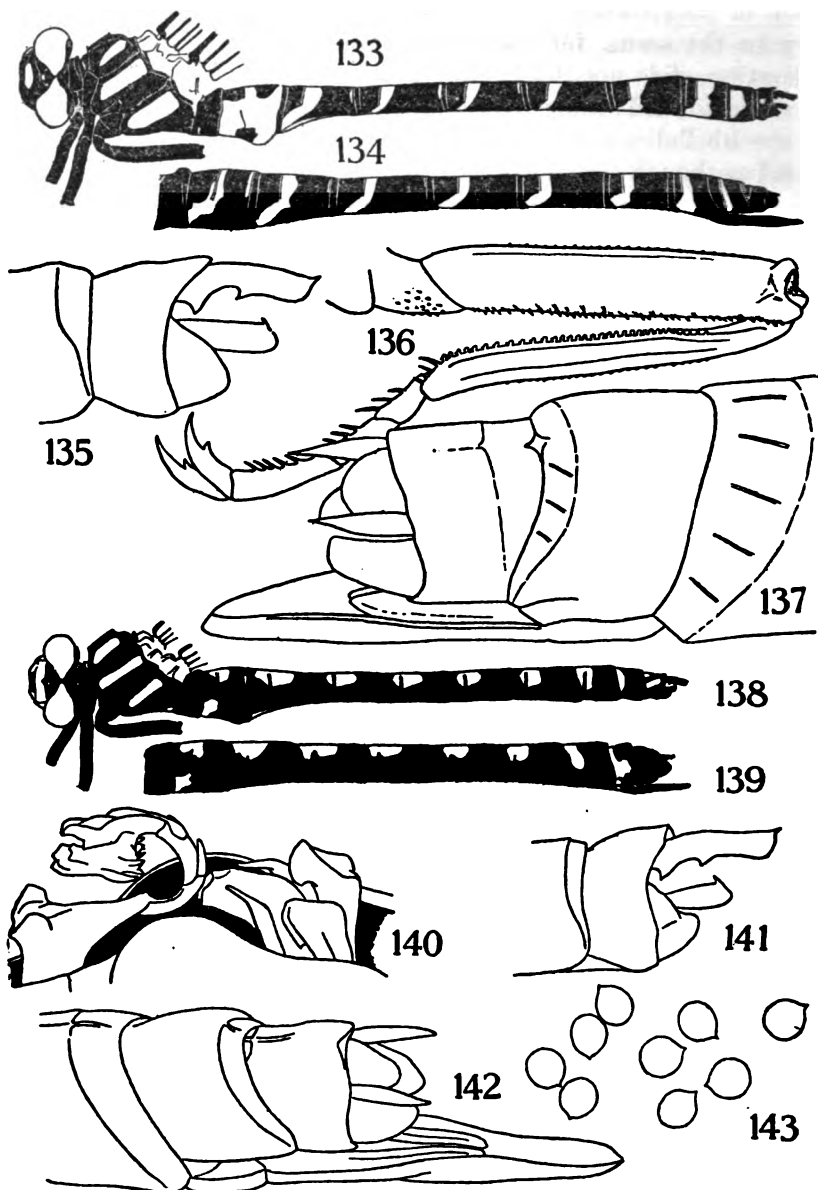
¹ See pages 559-562.

swiftness to become warm and muddy. In the steep and narrow mountain gorges where the rushing torrents pour down through the shade of the redwoods and alders, this dragonfly adds a note of mystery to the scene, for the individuals with their strange ophidian coloration glide noiselessly up stream or down, never showing that curiosity toward strangers or unusual surroundings which is exhibited by the libellulines of the sunny valleys, but always moving straight ahead as though drawn irresistibly onward. Only males are common on the streams, the females seldom resorting to the water except to oviposit. The males, as indicated above, fly on the longest beats I have observed for any dragonfly, for they fly continuously up stream or down until they come to the head of the stream or to the slow water below, or until some unusual obstruction turns them aside, when they face about and fly as steadily in the opposite direction. The course is usually a foot or two above the surface of the stream and goes through dense shade and any loose brush or foliage which may hang over the water. *Octogomphus*, with the possible exception of *Aeshna walkeri*, is the only other western dragonfly which will fly in such close dark places. Because of this habit of flying in long beats this dragonfly is not easily taken, as the collector has but a single chance at each individual.

I have seen but one female over the water. This one was ovipositing. I have seen two others which I thought were females on the mountain side several hundred feet above the stream. As I have seen many males on the streams and only the single female, I conclude that these seldom resort to the water except to oviposit.

In the streams of the Coast Mountains of California, where I have had opportunity to observe the habits of *Cordulegaster* most, it shows a marked upstream migration of the imagoes. The eggs are laid in the shallow water along the edges of the stream and the nymphs wander aimlessly over the bed. Because the nymphs are free on the stream bottom each freshet during the three or four years of nymphal life serves to wash them farther down stream so that when they come to emerge they may be far downstream from the place where the eggs were deposited. On Stevens Creek (Santa Clara County, California) exuviae were abundant almost down to the Trout Farm, while few imagoes were seen below Soda Spring, which is 2 miles farther up the creek, and imagoes were common on the divide at the head of the creek, where few exuviae were found. Exuviae were abundant on the lower part of Zyante Creek (Santa Cruz County, California), where no adults were seen, though it was at the height of the *Cordulegaster* season. From the above and similar observations on *Octogomphus*, I have concluded that the imagoes show such a preference for the swifter water of the upper reaches of these streams that when they reach the upper part of the stream in their first flights they remain

there. This, then, would appear as a general migration of the imagoes upstream.

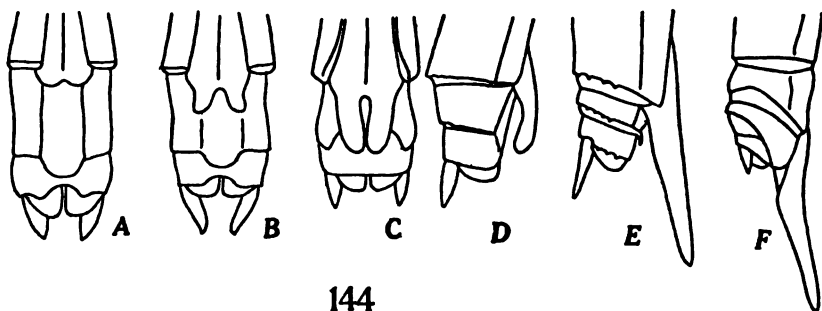


FIGS. 133-137.—*CORDULEGASTER DIADEMA*. 133-134. COLOR PATTERN. 135. SEGMENT 10 OF MALE. 136. FORE LEG OF MALE. 137. SEGMENTS 9 AND 10 OF FEMALE.

FIGS. 138-143.—*CORDULEGASTER DORSALIS*. 138-139. COLOR PATTERN. 140. PENIS AND HAMULES. 141. SEGMENT 10 OF MALE. 142. SEGMENTS 9 AND 10 OF FEMALE. 143. EGGS.

I have never observed copulation in this species, but in the matter of oviposition I was more fortunate. August 16, on Stevens Creek,

I saw a female oviposit and a chance acquaintance described to me the manner of oviposition of another female that agreed with my own observations, which are as follows: The female flew hurriedly up the creek and every few yards stopped and with a sudden backing or downward stroke, while hovering with the body in a perpendicular position, stabbed her large ovipositor into the coarse sand along the stream edge where the water was about 1 inch deep. She thus thrust her abdomen down through the inch of water driving her ovipositor into the sand beneath. Four to ten such perpendicular thrusts were made at each stop. Some stops were along the open beaches, but more were in quiet nooks between large rocks where she would have barely room enough for her wing expanse. She usually faced the center of the stream while ovipositing, though once she faced upstream and once toward the bank. The peculiar perpendicular position with the up and down motion reminded me strongly of the manner of



144

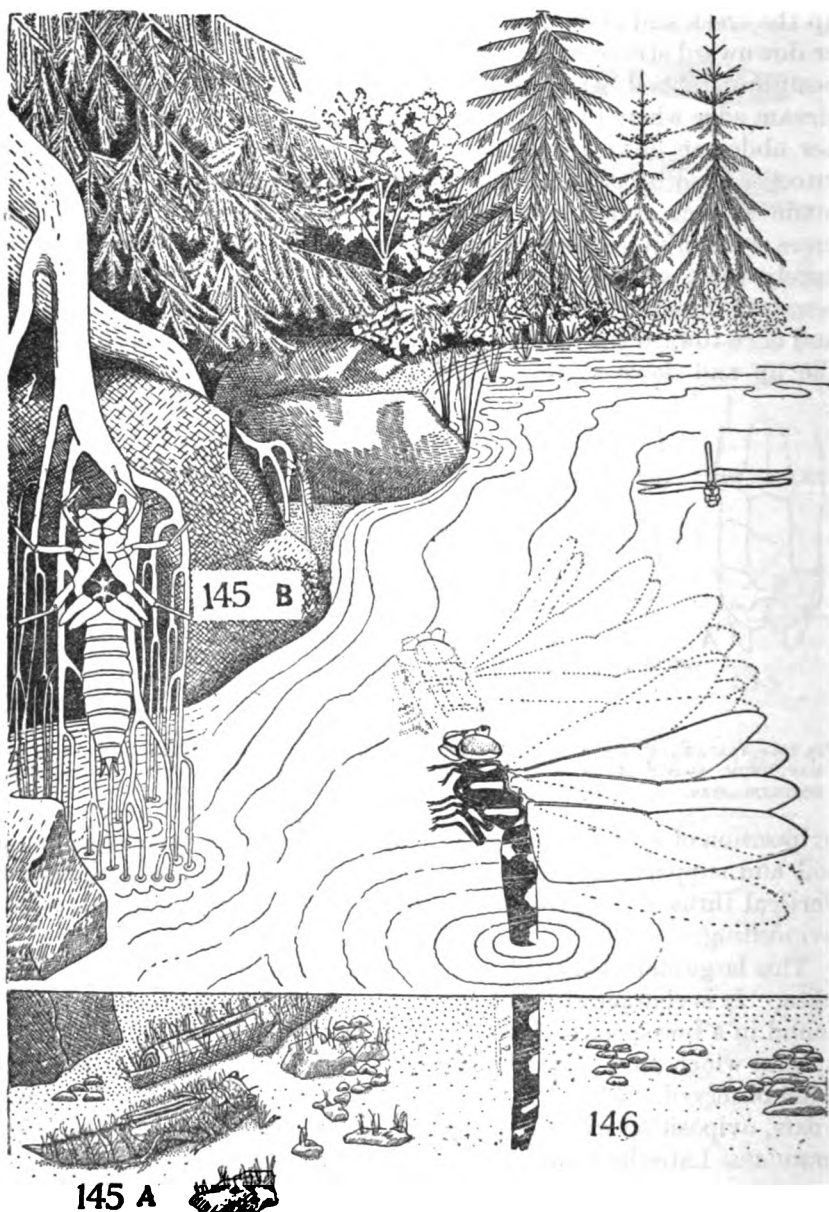
FIG. 144.—VULVAR LAMINA AND OVIPOSITORS (FROM RIS) IN: A. *SYMPETRUM FREQUENS*. B. *SYMPETRUM MATUTINUM*. C. *SYMPETRUM ERYTHRUM*, VENTRAL VIEW. D. SAME, LATERAL VIEW. E. *SYMPETRUM CORDULEGASTER*. F. *URACIS OVIPOSITRIX*.

oviposition of some crane flies, except that the latter oviposit in damp soil and support themselves on their slender legs while making the vertical thrusts. Figure 146 shows the position of the female while ovipositing.

This large shovel-shaped ovipositor is found in few species of Odonata. It is characteristic of the subfamily Cordulegasterinae and is found in a few species of the Libellulinae. This is the third of those species which have this style of ovipositor, in which oviposition has been observed. After the matter had puzzled naturalists for many years, oviposition was first observed for the European *Cordulegaster annulatus* Latreille by Ris, who described it as follows:¹

Cordulegaster (annulatus), when ovipositing, flew vertically. It thrust the hindmost pointed part of the abdomen vertically in the crumbled limestone deposit on the bottom of the very shallow water.

¹ Ent. News, vol. 16, 1905, p. 112.



FIGS. 145-146.—*CORDULEGASTER DORSALIS*. 145, A. NYMPH WITH PROTECTIVE COAT OF ALGAE. 145, B. EXUVIA. 146. FEMALE OVIPOSITING IN STREAM BED.

Later Williamson observed *Cordulegaster maculatus* Selys of the eastern United States while in the act of ovipositing, which he described as follows: ¹

Cordulegaster maculatus was observed to fly down from trees, alighting on algae-covered rocks in the stream bed. On portions of these rocks not covered with water they crawled about in an awkward, almost crippled manner, thrusting their abdomen with much commotion into the algae beneath the water.

An interesting summary of our knowledge of oviposition in *Cordulegaster* is given by Dr. C. Wesenberg-Lund in *Odonaten-Studien*.²

It is interesting to note that this very special form of ovipositor may not be of any great systematic significance. It occurs in all of the few cordulegasterine Odonata known. It is found in the libelluline genus *Uracis* (see fig. 144, F, *Uracis ovipositorix* Calvert), the several species of which occur in South America and have habits of oviposition similar to those of *Cordulegaster* except that they oviposit in the mud about the water. More strange yet is the fact that a single species of the large genus *Sympetrum* of the North Temperate Zone has this same highly specialized ovipositor. This species, *Sympetrum cordulegaster* (Selys) (see fig. 144, E), occurs in northeast Asia and nothing is known of its habits. While the majority of the *Sympetrum*s have no ovipositor and oviposit by washing the eggs from the tip of the abdomen, one or two Asiatic species have extraordinarily long vulvar laminae and form a sort of connecting series between the numerous species of *Sympetrum* with no laminae or very small ones and this freak species, *Sympetrum cordulegaster* (Selys), with the vulvar laminae longest and united into a monster ovipositor (see fig. 144, E), *Sympetrum frequens* (Selys), with small vulvar laminae (fig. 144, A) and *Sympetrum eroticum* (Selys), from Japan, with very large vulvar laminae but these not united into an ovipositor (fig. 144, C and D). Figure 144, B, is *Sympetrum matutinum* Ris, an intermediate form. These widely scattered cases of this special form of ovipositor are an excellent example of convergent evolution.

As neither of the western species of *Cordulegaster* has been well figured, I have shown in the figures some of the peculiarities of structure and have represented the color patterns diagrammatically. *Diadema* is slightly larger than *dorsalis*. A male and female of *diadema* measure as follows: Male, abdomen, 64 mm., hind wing, 48; female, abdomen, 65 mm., hind wing, 55. Male and female of *dorsalis* measure as follows: Male, abdomen, 55 mm., hind wing, 44; female, abdomen, 57 mm., hind wing, 45. As is shown in the figures 135, *diadema*, and 141, *dorsalis*, the appendages on segment 10 of the female do not differ noticeably. Figure 136 shows the peculiar armature of the tibia in *diadema* which does not differ from that in *dorsalis*. Figure 140 shows the organs of segment 2 of the male *dorsalis*, which are very simi-

¹ Ohio Nat., vol. 7, 1907, p. 144.

² Mitthl. biol. Süßwasserlab. Halleröd (Denmark), No. 16, p. 187.

lar to those of *diadema*. These are characterized by the very large swollen head of the penis and by the thin shell-like anterior hamules. Figure 143 shows the eggs of *dorsalis* drawn to the same scale as the abdominal segments 9 and 10, figure 142. Figures 137, *diadema*, and 142, *dorsalis*, show the ovipositors of the females. The ovipositor consists of a large ventral ovipositor proper which arises from the eighth segment and in the nymph is divided longitudinally. This may be homologous to the ovipositor in the Aeshninae. In the concave dorsal surface of this lie a pair of slender organs which in the nymph arise from the ventral surface of segment 9. These in *diadema* do not extend caudad beyond the apices of the appendages of segment 10, but in *dorsalis* are much longer. These, because they arise from segment 9, may be homologous to the genital valves of the aeshnine dragonflies, though their position in the imagoes is just the reverse of these parts in the Aeshninae.

In color the two species are similar. The general color in teneralis is chocolate brown which, in age, may become almost black. The markings are pure yellow. The frons in *diadema* is black with a yellow oval on its dorsal surface while in *dorsalis* it is yellow with a dark band across its anterior face. The markings of the abdomen in *diadema* are characterized by the yellow oblique rings on segments 3 to 8, and in *dorsalis* by the subcircular dorsal spots on segments 2 to 7. The eyes in *dorsalis* are gray. (See figs. 133-134 and 138-139.)

The nymphs of *Cordulegaster* are short-legged, slow-moving creatures and are usually abundant in the streams of the Coast Mountains. They occur with *Octogomphus* nymphs in the leafy trash of the eddies, but are also found crawling slowly about over the bed of the stream. Their very slow and apparently cautious movements do not betray them, and they carry with them further protection in the coat of long hairs which collects dirt and on which flourishes a thick growth of filamentous algae (see fig. 145, A). Because of this covering of dirt and algae the nymph, though on an otherwise barren bottom, will usually escape the closest scrutiny of the collector, for it does not appear any different from a stick or stone covered with dirt and aquatic growths.¹

At emergence, which takes place in June (I found a single exuvia May 31), the nymphs crawl from 1 to 5 feet up the trunk of the nearest alder tree (see fig. 145, B). A male was reared in the laboratory, but the hour of emergence was not ascertained. This species spends four years in the egg and nymphal stages.

The following table shows the four sizes of nymphs I collected on Stevens Creek (Santa Clara County, California) during the past summer. The measurement used is the width of the head (eye to eye);

¹ On Mission Creek, Santa Barbara, California, I found nymphs of *dorsalis* buried in flocculent silt, as is described by Dr. J. G. Needham (N. Y. State Mus. Bull. 47, 1901, p. 478) for the various eastern species of this genus.

length is unreliable, for some have swollen and some have shrunken in alcohol.

Collected.	1918 brood.	1917 brood.	1916 brood.	1915 brood.	1914 brood.
		mm.	mm.	mm.	mm.
May 31, 1914.....		4			
Do.....		4			
Do.....		3.75			
Do.....			5.5		
Do.....			5.5		
Do.....			5		
Do.....			5		
Do.....			5		
Do.....			5		
Do.....				7	
Do.....				6.75	
Do.....					8.5
Do.....					8
Aug. 16, 1914.....		4			
Do.....				6.5	
Do.....				6.5	
Do.....				6.5	
Do.....					Numerous exuviae.
Do.....					
Do.....	Eggs from 1914 fe- males.				

With these differences in size go much more marked differences in structure. In the 1917 brood or smallest size, the wing pads are minute triangular projections, which are erect and do not overlap. In the 1916 brood they are 2 mm. long, and are no longer erect but overlap three-fourths of their length. In the 1915 brood they are 5 mm. long and assume the adult shape and position. In the mature nymph or 1914 brood they are 9 mm. long. The sex appears in all sizes. In the smallest or 1917 brood the females are distinguished by a pair of minute tubercles at the posterior edge of the ventrum of segment 8. In the next size, 1916, these are distinct triangular projections, though very minute, while in the next size, 1915, they assume the adult shape but are only half the length of segment 9, while in the adult nymph they are slightly longer than segment 9. The male organ on segment 2 is less apparent, being distinct in the adult stage only.

The nymphs of both *dorsalis* and *diadema* have been described by Needham¹ (fig. 147 is copied from Needham's description and shows the divided median tooth of the middle lobe of the labium in the two species).

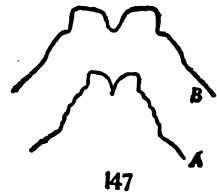
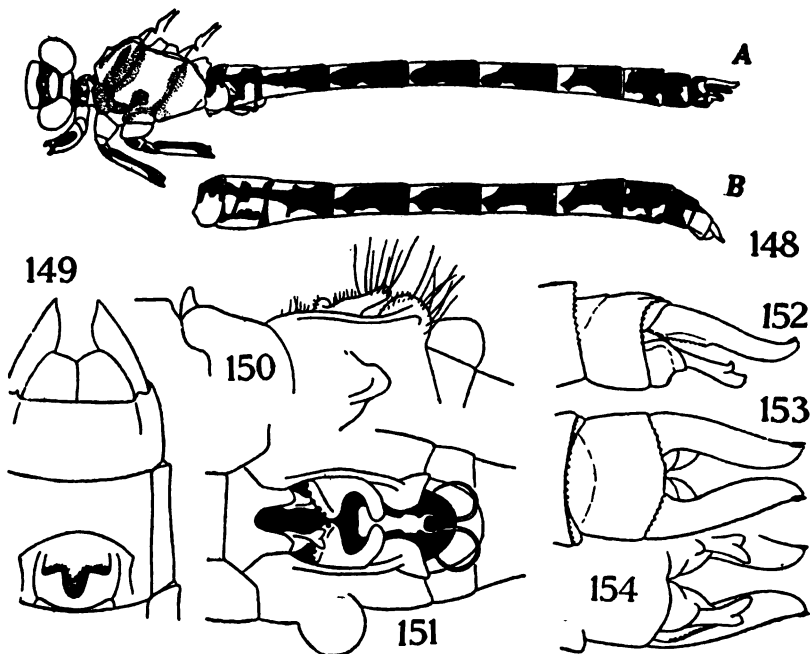


FIG. 147.—DIVIDED MEDIAN TOOTH OF MIDDLE LOBE OF NYMPHAL LABIUM (FROM NEEDHAM). A. CORDULEGASTER DORSALIS. B. CORDULEGASTER DIADEMA.

¹ Proc. U. S. Nat. Mus., vol. 27, 1904, pp. 696, 697.

9. NOTES ON *PROGOMPHUS BOREALIS*, WITH A DESCRIPTION OF ITS NYMPH.

This western *Progomphus* is apparently widely distributed throughout California,¹ but during the summer's collecting I have seen not more than ten or twelve specimens on the wing. Perhaps the expression "widely distributed" should be used with some qualification as under it I have included the evidence from the wide distribution of the nymphs, which I have ascribed to this species. These nymphs



FIGS. 148-154.—*PROGOMPHUS BOREALIS*. 148. COLOR PATTERN. 149. SEGMENTS 9 AND 10 OF FEMALE. 150-151. SEGMENT 2 OF MALE. 152-154. SEGMENT 10 OF MALE.

seem to occur in the drifting beds of all the sand-bottomed streams of central and southern California where there is a permanent flow of water.

I have the following records of adults: Chico River, five miles east of Chico, California, several males caught on June 17, 1914; Coyote Creek, San Jose, California, two seen on July 4, 1914. Mr. Fordyce Grinnell, jr., has collected specimens at Los Angeles, May 27, 1900, and on Mount Wilson, August 3, 1904. He has also a record from the Santa Rosa Mountains (Riverside County, California) and a specimen from the San Jacinto Mountains, California, at an elevation of 2,500 feet, this taken June 17, 1908.² The nymphs associated with this

¹ Calvert (Biol. Cent. Amer., p. 151) records *borealis* from both Oregon and Arizona as well as from western Mexico, where it extends down the west edge of the plateau as far as Uruapan.

² In August, 1915, I found *borealis* abundant in the Mojave River at Victorville. None were found in the Owens River Valley nor in the Leontin Basin. Apparently it does not occur immediately east of the Sierras.

species were common in the American River at Sacramento, Kings River at Readley, the San Joaquin at Friant, and Kern River at Bakersfield, which are all wide, shallow streams with beds of drifting sand.

Apparently this species has a long season on the wing as Grinnell's records are from May to August. On the Chico River the few individuals I saw were flying about a quiet pool at the head of a long rapids and when not in motion were seated on snags in the water or on the gravelly shore. Their habits seemed much like those of *Ophiogomphus bison* with which they were associated, except that they were much more wary and difficult to capture. Their large size, slender abdomen and peculiar brown thorax readily distinguish them in the field from any other western gomphine.

Both the imago and nymph of this slender, graceful species differ widely in structure from any other western gomphine. The anterior hamules in the male are covered by wide laminae on the posterior hamules and the seminal vesicle is invaginated on its anterior face, which makes a deep hollow in which the two long filaments of the penis are coiled when in repose. The inferior appendage of the tenth segment is divided to its base, making a pair of inferior appendages. (See figs. 150-154.)

In life *Progomphus borealis* is noticeable for the reddish brown of the front of the thorax and the yellow abdomen with the large black triangles on segments 3-8. In detail the color is as follows:

Male.—Entire face gray but horizontal surface of frons pale brownish; vertex dark brown, lighter posterior to the ocelli; occiput gray with brownish tinges; eyes gray. (I find that I have omitted the live eye color in my field notes.) Upper third of postoccipital region dark brown, lower two-thirds creamy with a horizontal brown stripe. (See fig. 148, A.)

Thorax with anterior surface pale brown and sides pearly gray. The following markings occur: An obscure reddish brown stripe on each side of the middorsal carina, these stripes wedge shaped, with the wide end below; a wide reddish brown humeral stripe, and anterior to this, separated by a pale line, a second wide stripe, the upper end of which usually connects with the upper end of the wedge stripe next the middorsal carina; a brown spot on the metathoracic spiracle and the second lateral suture brown; legs with coxae pale, femora pale with black apices and a black stripe on the upper and posterior surface of each; tibiae and tarsi black; wings hyaline except a reddish brown fleck at base which, in the costal and subcostal spaces, does not reach beyond the basal subcostal crossvein. There is no color in the origin of the sectors of the arculus, as occurs in the eastern species, *Progomphus obscurus*; costa yellow, pterostigma jet black.

The abdomen is creamy yellow with the following intense black markings: The upper half of segment 1, an irregular triangular spot on side of segment 2, an approximately triangular spot on the side of each of segments 3-7; the apex of each of these is at the anterior end of the segment, and the two spots on the opposite sides of any segment meet dorsally across the apical end; sides of segments 8-10 heavily mottled with black; superior appendages yellow; inferior black.

Female.—Colored as is the male, but the side of segment 2 with two horizontal black stripes and segment 10 largely yellow. (See fig. 148, B; 149.)

Five Chico males measure as follows:

Abdomen, 42-44 mm.; hind wing, 30. Two females from Los Angeles measure, abdomen, 43 mm., hind wing, 33-34.

The nymph of this species is more highly specialized for burrowing than any other odonate nymph with which I am familiar. It is the most frequently occurring form of large insect life found in the sand beds of the rivers of central and southern California.

All the rivers of California originate in the mountains as swift, clear streams, but nearly all before reaching the sea have almost level lower courses where they lose their swiftness, become warm and meander over beds of shifting white sands. These sand beds are so unstable that they actually flow with the water though at a much slower rate. Perhaps this needs further explanation. A good example is that of the Kern River at Bakersfield. Above the intake of the irrigating canal in the latter part of summer this river was on an average a foot deep and one hundred feet wide. Its bed was of pure, loose sand. This was formed by the current into sand ripples which faced with their steep slope down stream. The sand was in constant movement as the current carried sand from the upper gradual slope, up over the crest of each ripple to let it drop down the steeper downstream slope. Where there were eddies and turns these sand ripples became waves in size, being frequently six inches to a foot high though they were usually less than 6 inches in height. In such a stream the bottom inch of water is turbid with moving sand.

It is in such an unstable environment that *Progomphus* flourishes. Only once or twice have I actually found nymphs in the flowing streams but in any side channel where the water has ceased to flow the sand bed is marked in all directions by the curving burrows of these wandering nymphs. They burrow in the loose upper stratum of sand and just deep enough to cover the back. Usually the tenth segment protrudes. I have traced burrow tracks that were from ten to fifty feet long. If one arrived at the fresh end of the burrow before some water fowl had found it the nymph would be found spasmodically burrowing forward. These nymphs could burrow as rapidly as the average nymph can walk. Only such vigor and speed

could save an insect of this size from being buried in the moving sand.

The nymph of *Progomphus* has been described by Dr. J. G. Needham as follows:¹

Head depressed, sloping anteriorly, cordate, broadly notched behind; hind angles rounded. Antennae inserted into cylindroid elevations on the front, depressed and incurved so as to almost surround the pilot-shaped labrum: two basal joints very short; third, twice as long as the two basal combined, slightly flattened and upcurved at the tip; fourth joint small, one-third to one-fifth [*obscurus*] as long as the third, slender and strongly recurved.

Labium rather small, reaching, when folded, to the bases of the middle legs; submentum shortened; mentum narrowed at its proximal end, its median lobe prominent, rounded, fringed with a row of flabellate scales whose bases are overlaid by another row of shorter semicylindrical scales; beneath this fringe, the margin cut into a series of obscure rectangular teeth; lateral lobes short, nearly straight, unarmed, rounded at apex; movable hook stout, moderately incurved, and tapering.

Thorax sloping to the head and to the bases of the legs; prothorax of unusual dimensions on the dorsal side, its hind margin on line with the bases of the hind legs, being extended back upon the other thoracic segments, shield shaped, with a short collar close behind the head. Wing-cases strongly divergent. Legs conspicuously fossorial, fore legs approximate to the sides of the head, bearing shields of stiff hairs behind which the middle legs may be brought forward. Middle legs approximated on the venter, rotated downward and extended horizontally close under the fore legs. Hind legs longer, more nearly normal, directed posteriorly. Fore tarsi with soles facing laterally; middle tarsi rotated on tibiae so as to point backward; hind tarsi elongate, the third segment about as long as both basal segments, its claws sharp and long; claws of fore and middle tarsi short and blunt. Each femur with a distal anterior process which rests against and supports the tibia when moved backward.

Abdomen spindle-shaped [*obscurus*], segments about equal, the ninth a little longer than the others; dorsal hooks variable, rudimentary, more or less well represented on segments 2 to 9 [*obscurus*]. Lateral spines on 5 to 9 [*obscurus*], on 5 rather minute. Appendages slender, tapering, superior and inferiors equal, about one third longer than segment 10, laterals about half as long as the others.

The preceding description was written for the eastern species, *Progomphus obscurus* (Rambur). I believe the Pacific coast form to be a distinct species, so it would have to be called *Progomphus borealis* McLachlan. It differs in the imago in being larger than *obscurus* and in having a single row of denticles on the inferior side of the male superior appendages (fig. 154). In *obscurus*, as pointed out by Calvert,² the posterior end of this row is double or treble.

I have quoted the description of *obscurus* from Needham and have figured the *borealis* nymph to show that the differences between the two species are more conspicuous in the nymph than in the adult. (See figs. 155-163.)

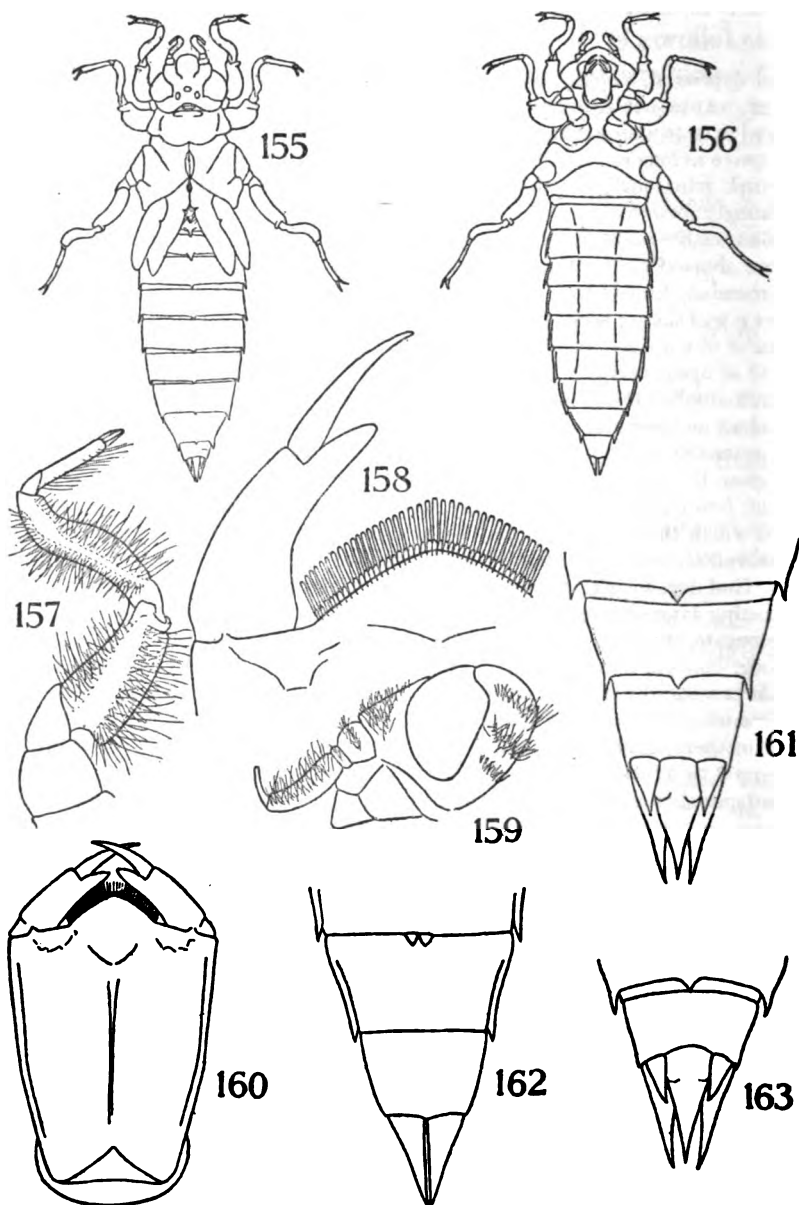
The specific characters of the *borealis* nymph may be given as follows:

Length shorter than that of *obscurus* nymph and width greater so that the *borealis* nymph has none of the appearance of extreme slenderness as

¹ Needham and Hart., Bull. Ill. State Lab. Nat. Hist., vol. 6, art. 1, 1901, pp. 55-56.

² Biol. Cent. Amer., Neur., p. 149.

in *obscurus*.¹ Fourth segment of antenna nearly one-half as long as third (in *obscurus* one-third to one-fifth.) Abdomen with lateral



FIGS. 155-163.—*PROGOMPHUS BOREALIS*, NYMPH. 157. FIRST LEG. 158. MENTUM, DETAIL. 159. HEAD. 160. MENTUM. 161. SEGMENTS 9 AND 10 OF MALE. 162-163. SEGMENTS 9 AND 10 OF FEMALE.

spines on segments 3-9 (in *obscurus* on 5-9); dorsal spines on segments 1-9, those on segments 1-3 large and recurved, the remainder

¹ Needham and Hart., Bull. Ill. State Lab. Nat. Hist., vol. 6, art. 1, 1901, p. 94, pl. 1, fig. 3.

minute (in *obscurus* on segments 2-9, and only that on segment 2 developed).

Length of abdomen, 18 to 20 mm.; width of abdomen, 7; length of hind femur, 4.

10. THE WESTERN SPECIES OF OPHIOGOMPHUS, INCLUDING A NEW SPECIES AND TWO NEW VARIETIES.

Ophiogomphus is a genus in which nearly all of the species live on streams or lakes which have gravelly beds or beaches. Because of this preference of *Ophiogomphus* in the matter of environment nearly all of the species are restricted to either the Appalachian region or to the mountainous portions of the western half of the United States. In Muttkowski's catalogue six species¹ are listed from this western region. In my collecting during the past two summers I have taken all these six species except *montanus*, and *phaleratus*, which Prof. J. G. Needham described from a single male captured on the Willamette River of Western Oregon.² The individuals of *Ophiogomphus*, while apparently emerging in considerable numbers, are scarce and seldom found except on gravel bars or gravelly rapids, which are places usually avoided by collectors. Occasionally the odonatist stumbles onto a place where a single species is very abundant. *Severus* was abundant on Satus Creek, in Yakima County, Washington. *Occidentis* was abundant in the two acres of sagebrush at the mouth of the Umatilla River in Oregon, and *morrisoni* was common on the north beach of Donner Lake, California. But during the more than three months of actual field work, the most of which was spent on streams, a half dozen specimens of *Ophiogomphus* after having walked 6 or 7 miles of stream was considered a good days catch.

The imagoes of the various species spend the greater part of their time seated on gravel bars from which they fly up at intervals to catch insects or to intercept individuals of their own kind. They are rarely found far from running water.

Copulation is a lengthy affair. The male usually captures the female as she flies along the water's edge on her business of oviposition, when he grasps her head with his feet and then, bending his abdomen forward, grasps her occiput with his claspers while freeing his feet. She in the meantime bends her abdomen forward and copulates. After a short nuptial flight the pair settles on some bush and remains in copulation many minutes. In ovipositing the female deposits the eggs in swift water, usually on rapids, where she flies back and forth dipping the tip of her abdomen in the stream. Though the eggs are laid on the shallow rapids, the nymphs during the latter part of their life live in the muddier bottom of the quieter water, for

¹ *Sequoiarum* was described by Miss Butler in Can. Ent., vol. 46, 1914, p. 346, but is a synonym of *bison*.

² Since arriving at Cornell University I have examined the type of *phaleratus* and find it to be a form of *occidentis*.

the exuviae are usually found along the edges of the deeper pools. Nymphs of *severus* from Satus Creek, Washington, indicate a three-year period for their life cycle. See pp. 544-549 for nymphs.

Mites rarely infest the species of this genus, and as imagoes they have few enemies except the birds which attack them while tenerals. *Ophiogomphus morrisoni* on Donner Lake was seriously attacked by robins while emerging. As with many western species the most serious cause of premature death among imagoes seemed to be the occasional cold rains which come even in desert regions. On Satus Creek I have seen *severus* practically wiped out for the first day or two after a rain and regaining its numbers only after more had emerged. Very old imagoes show a condition which might be called the "staggers." They appear weak or drunk and on alighting will commonly fall over on their sides and regain their feet with difficulty.

The following notes cover the species of *Ophiogomphus* I have taken in California and Nevada. With them I have included *Ophiogomphus severus montanus* and a new species from Arizona, though neither has been recorded from this territory. Hagen's reference of *severus* in Nevada is probably *nevadensis*. It is probable that *severus* will be found in the northern part of this area and that the new species, *arizonicus*, will be found in the southern part.

The forms listed fall into the following four groups:

Females without occipital spines.

Group I. *a*¹. Size small (abd., male, 34-36 mm.); humeral suture with a narrow stripe preceded by an oval spot; posterior hamules broadly truncate.

*b*¹. Pale, markings brown.....*severus*.

*b*². Markings black.....*montanus*.

*a*². A double humeral stripe (the anterior stripe sometimes reduced to an oval spot in *nevadensis*); posterior hamules pointed.

*b*¹. Size small (abd., male, 35-36 mm.); superior appendages of male usually shorter than inferior; markings intense black; humeral stripe double, broad and black.....*morrisoni*.

*b*². Size larger (abd., male, 37-39 mm.); pale colors ashy; markings restricted; lateral stripe widely interrupted on segments 3 and 4; humeral stripe double, but each stripe narrow or the anterior reduced to an oval spot.....*nevadensis*.

Females with two occipital spines.

Group II. *a*¹. Occipital spines short and widely spaced; male with inferior appendage one-half length of superiors; humeral stripe reduced to a line and an anterior oval spot.....*arizonicus*.

Group III. *a*². Occipital spines slender and close together; male superior appendages long and cylindrical, the inferior three-fourths length of superiors; humeral stripe broad, heavy, and usually double.....*bison*.

Females with four occipital spines.

Group IV. *a*¹. A black, broad, double humeral stripe; entire pattern heavy; male inferior appendage with inferior profile almost semicircular.

occidentis.

*a*². Same as for *a*¹ but paler, the entire pattern brownish instead of black.....*californicus*.

OPHIOGOMPHUS SEVERUS Hagen.

Live colors, male.—Thorax green, abdomen yellow, markings dark brown.

Face yellow; eyes gray; vertex black; rear of head yellowish; occiput yellow. (See fig. 192.)

Thorax in teneral and young specimens clear pale green which turns yellowish olive in old specimens. It is marked as follows: Middorsal carina narrowly brown, which color extends along the antealar sinus to the humeral suture. This is narrowly brown and in some specimens the brown extends ventrad on the suture posterior to the mesinfraepisternum. A small oval spot on the upper end of the mesepisternum. (This spot distinguishes the species except from *arizonicus* and some individuals of *nevadensis*.) Legs creamy with an external black stripe on the femur of the first pair (in some specimens on the outer half only), and on the distal half of the femur of the second and third pairs; tibiae black with an external yellow stripe; tarsi black. Costa yellow; pterostigmas gray, even in old specimens.

Abdomen lemon yellow above the lateral markings, except on sides of segments 1 and 2, which are greenish; below the lateral markings the sides pure white. A sawtoothed brownish black lateral stripe on segments 2-9. In most males this stripe is broken into a series of detached triangular spots, one on the side of each segment. Segment 10 with obscure traces of this band. In old specimens the green of the thorax becomes yellowish olive, and the abdominal yellow deepens to a chrome especially on the sides of segments 7-10. In such old specimens the dark antehumeral spots fade and frequently disappear altogether.

Female.—Colored similarly to the male but the dark on the legs more restricted and the triangular spots on the abdomen lengthened and widened on the proximal end of each segment so as to give the effect of a continuous sawtoothed lateral band.

The female is readily distinguished from the females of other species, except *arizonicus*, by the narrow humeral stripe and the small oval antehumeral spot. (Some females of *nevadensis* may be colored thus, though the specimens I have possess the double humeral stripe.) Both sexes are distinguished from *nevadensis* by the lack of black on the second lateral suture of the thorax. The males are distinguished by the spatulate tips of the posterior hamules. (See figs. 193-197.)

Abdomen, male, 34-36 mm.; female, 35-36; hind wing, male, 28-29 mm.; female, 31-32.

The only place I have found this species, with the exception of Umatilla, Oregon, where I collected two specimens, is on Satus Creek, Yakima County, Washington, where it is abundant from June 15 to August



FIGURES 184, 185, 186. DRAGONFLY. 184-186. MALE, ABT.

...er stream, and then retur-
 ... the single tap. The imagoes
 ... the deeper pools.

OPHIOGOMPHUS SEVERUS MONTANUS (Selys).

Male.—Entire face yellow, except the posterior third of the horizontal surface of the frons. Vertex black. Occiput yellow. Rear of head yellow, edged with black along dorsal border. (See fig. 186.)

Prothorax black with an oval yellow spot on each side of posterior lobe.

Mesothorax and metathorax yellowish (green in life?), with the following black markings: A broad middorsal stripe, twice as wide below as above. Alar ridges black, the sinus pale. A narrow sharply edged humeral stripe widening to an oval in its upper half, anterior to which is an oval spot which in some specimens is two-thirds the length of the humeral suture. Mesinfraepisternum with a black line across its upper half. A black stripe curving caudad from the lower end of the humeral stripe around the ventral end of the mesepimeron and rising dorsad to terminate just anterior to the metathoracic spiracle. Second lateral suture narrowly black, this continued ventrad around the upper side of the metinfraepisternum. Coxae and femora pale (cream in life?); the dorsal surface of the fore femora black; the apical half of the dorsal surface of the hind femora black; the black on the middle femora intermediate in extent. Tibiae black with an external pale stripe. Tarsi black. Pterostigmas brown.

Abdomen colored as follows:

Segment 1 yellow with a pair of dorsal black spots.

Segments 2—10 with the dorsum black, each containing a mid-dorsal roughly triangular yellow spot extending from the base to the apical fourth; this spot on each segment and slightly constricted at the vertical carinae with its broad end cephalad. Appendages yellow. Probably in life the side of segment 2 is yellow, of 3-6 white and 7-10 rich yellow. (See figs. 186-189.)

Female.—Coloration identical with that of the male. (See figs. 190-191.)

Measurements.—Male, abdomen, 35-37 mm.; hind wing, 30-31; female, abdomen, 34-38 mm.; hind wing, 32.

In the Cornell collection are four males and four females of an *Ophiogomphus* which has appendages similar to those of *severus* but has a very dark coloration. The preceding description is based on these, which bear the label "Y P.,¹ Aug." They also bear the label *montanus*, having been identified by Prof. J. G. Needham. The superior appendages of the male, while resembling those of *severus* closely, are slightly more bulbous at the apex, the inferior is slightly longer than in *severus* and the apex of the posterior hamule hardly as truncate. Nevertheless, all these differences are so slight as to be negligible.

¹ Yellowstone Park.

The coloration, however, is remarkable in the extent of the black markings, which give the species the appearance of *morrisoni*, except that the antehumeral black stripe is reduced to an oval spot. This form is of interest because the Columbia River form is pale (the true *severus* form) and the State of Colorado form is also pale (probably the true *severus*), while this form (*montanus*) is intermediate geographically, but very dark. This darker form may be due to the great altitude of Yellowstone Park.

It is possible that a more extensive survey of the Northwest will show that *severus*, *montanus*, *morrisoni* and *nevadensis* are forms of the same species. Some males of both *morrisoni* and *nevadensis* have appendages very similar to those of *severus* and *montanus* (see figs. 177, 180, 188, 194). The resemblance occurs also in the nymphs, as these have three pairs of lateral abdominal hooks in *severus*, *morrisoni*, and *nevadensis*. The nymphs of *montanus* are unknown.

OPHIOGOMPHUS MORRISONI Saty.

Live colors, male.—Olive green thorax and chrome-yellow abdomen; markings intense black. (See fig. 170.)

Face greenish-yellow with a narrow black line above the labrum and usually another above the nasus. Dorsal surface of frons black on its posterior half; vertex black except an oval spot posterior to the postocellar ridge; occiput yellow. Eyes gray, darker above.

Thorax olive green with the following intense black markings: Middorsal stripe 2 mm. wide at the bottom and narrower above; antearlar ridge and sinus covered by a line 1 mm. broad, which connects with a double humeral stripe 2 mm. broad. This humeral stripe has a narrow green stripe running the entire length of its central line; this green stripe 0.5 mm. wide below. A stripe 1 mm. broad borders the mesinfraepisternum above and posteriorly, and connects with a similar stripe on the dorsal half of the metinfraepisternum. Lower third of first lateral suture black. A stripe 0.5 mm. wide runs from the antearlar sinus below the fore wing to the second lateral suture; a stripe on the second lateral suture 0.5 mm. broad. Legs pale greenish gray; the femora with a heavy external (dorsal) stripe the full length, which is less heavy or interrupted on the hind femur; tibiae black with an external pale stripe; tarsi black. Costa yellow; pterostigmas brown.

Abdomen intense chrome yellow above, greenish yellow on sides of segment 1, yellow on sides of segments 2, and 7-10, and white on the sides of segments 3-6. Markings intense black as follows: A band 1.5 mm. wide on the upper side of segment 1 running caudad and meeting its fellow on the middorsal apex of segment 2; a spot on the anterior end of segment 1 and a spot posterior to the auricle; a lateral stripe extending from segments 3-10 which is broken into a

series of triangular spots, one each on segments 3, 4, and 5 and which widens caudad to 1.5 mm. on segment 8. On each segment a broad band across the apical end, occupying the apical fourth on segments 3, 4, and 5, apical third on 6 and 7, and apical half on 8 and 9. In some specimens the lateral bands are most widely connected dorsally on segment 6, being less widely connected on segments 7-9. No connecting apical band on segment 10. Appendages yellow. Apical ventral angles of segments 3-8 with a black spot. (See also figs. 171-173.)

Female.—Colored similarly to the male but some of the females have black on the mesinfraepisternum greatly reduced or in one specimen even lacking. Usually the spots in the apical ventral angles of segments 3-8 are detached. (Vulva, fig. 174, occiput, fig. 175.)

In some specimens of both sexes the two parts of the humeral stripe are separated for their entire length. Such, while resembling *nevadensis*, never have the black stripes as narrow (see figs. 176 and 184). This species differs from the other western species in its intense varnished appearance due to the scanty pile.

Abdomen, male, 35-36 mm.; female, 36-37.5; hind wing, male, 28-30 mm; female, 32-33.

This is the only species of *Ophiogomphus* I have found in the Transition and Canadian Zones. It occurred in Oregon on the Big Meadows of the Deschutes, 18 miles south of Bend, which lie at an elevation of about 4,000 feet. Here it was associated with northern species such as occur at sea level in northern Washington or southern Canada. On Lake Tahoe, which has an elevation of 6,000 feet, on August 1, I collected a single male of this species at the mouth of Emerald Bay. In a week's collecting along the shores of the lake this was the only specimen of *Ophiogomphus* I saw. Collecting on Tahoe may have been better at one time, for the Reclamation Service has recently raised the lake level several feet by a dam across its outlet, which has very evidently disturbed the littoral fauna.

The place where *morrisoni* occurred in its greatest abundance was on Donner Lake, which has an elevation of 5,000 feet, or 1,000 feet lower than Lake Tahoe. Here it was associated with almost the same series of northern forms as were found with it on the Big Meadows in Oregon. Three distinct kinds of beaches occur around this lake. At its western end is pure sand where *Gomphus donneri* occurs. Along the northwest shore is a series of gravel beaches which are gradually displaced, as one passes toward the east end of the lake, by cobble beaches. At the eastern end near the outlet, gravel occurs again. *Ophiogomphus morrisoni* is found on these gravel beaches.

The males rest on the cobblestones scattered over the gravel or pursue each other in zigzag flights along the lake shore. The females are not as numerous and are usually found seated on stones very close to the edge of the water. Here the males find them and take

them back among the bushes in copulation. In ovipositing the female poises just over the water and as the wave passes beneath her drops the tip of the abdomen into the water, raising it again as soon as the wave has passed. Emergence occurred between 10 in the morning and 4 in the afternoon. Usually the nymph crawled just above the wash of the waves. Robins caught many of the teneral among the rocks.

OPHIOGOMPHUS MORRISONI NEVADENSIS, new variety.

Type.—Cat. No. 21143, U.S.N.M. A male, Pyramid Lake, Nevada, August 4, 1914.

Allotype.—Cat. No. 21143, U.S.N.M. A female, Humboldt River, Carlin, Nevada, August 7, 1914.

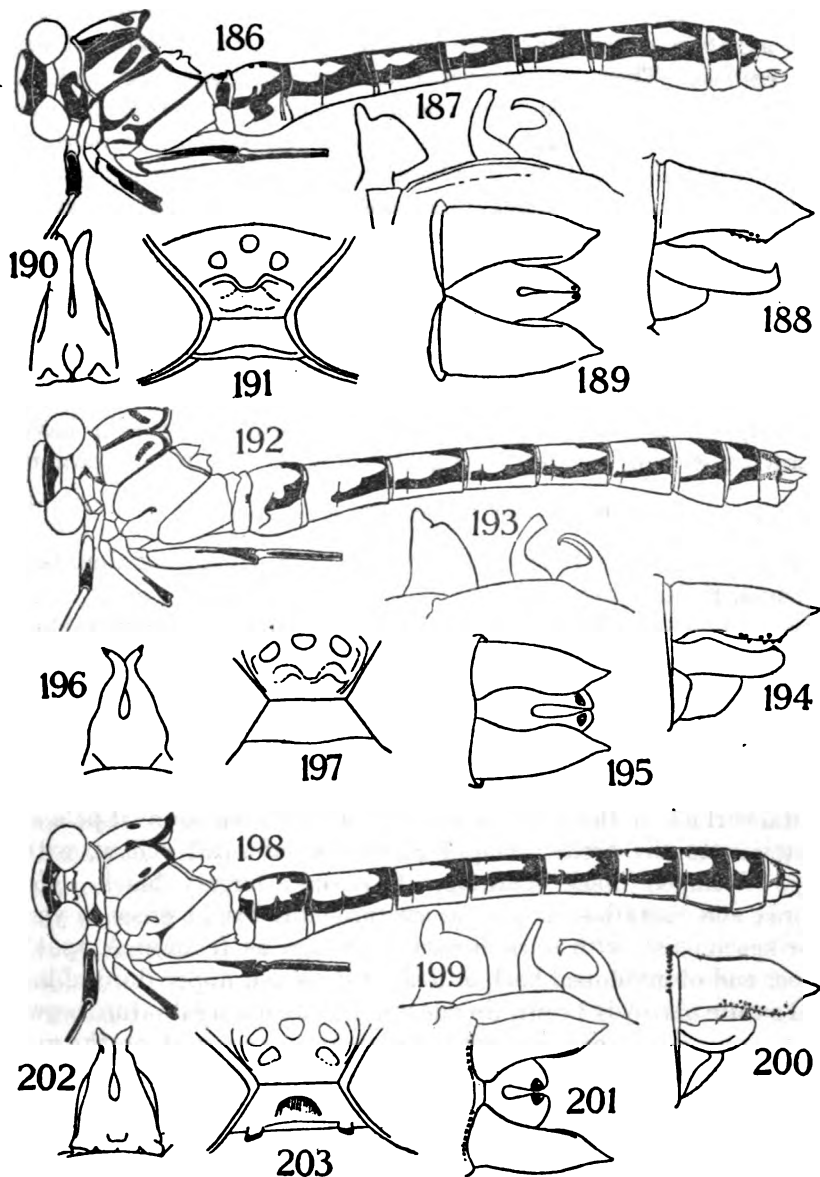
Live colors, male.—Thorax greenish gray, abdomen pale yellow and white, markings dark brown.

Face pale greenish gray with an obscure dark line above labrum; posterior edge of the horizontal surface of the frons black; vertex black except oval postocellar pale spot; occiput yellow; eyes gray, darker above (See fig. 178.)

Thorax grayish olive green with the following dark markings: Middorsal stripe 1.5 mm. wide at lower end, narrower above. Antalar ridge brown. Humeral stripe usually double, each member being 0.5 mm. wide at the upper or wider end. The stripes are widely separated for their entire length. In two of the six males the anterior humeral stripe is represented above by an oval spot only, and a small dot below. (This form has been confused by Hagen with *severus*, from which it differs in the pointed posterior hamules.) A black line crosses the dorsal end of the mesinfraepisternum and connects along the posterior edge of the same plate with a black line on the lower third of the first lateral suture. Second lateral suture narrowly black. Metinfraepisternum entirely yellow. Lateral alar ridge narrowly brown. Femora creamy with dorsal surface of front femora black, the distal half of the dorsal surface of the middle pair black and the distal third of the hind pair black; tibiae black with an external pale stripe; tarsi black. Wings lightly flavescent (not brownish as in *morrisoni*). Costa pale yellow; veins brown; pterostigmas grayish brown.

Abdomen creamy yellow above, tinged with green on sides of segments 1 and 2, white on lower sides of segments 3-6, and chrome yellow on sides and dorsum of segments 7-10. Sides with a sawtoothed stripe, lacking on the anterior half of segment 3 and broken on the anterior ends of segments 4-7. The dorsal angles of the "sawteeth" of the lateral stripes meet broadly on the middorsal line of the posterior end of segments 3-6. Segment 10 wholly yellow, except a small spot on either side and a smaller one between bases of dorsal appendages. Appendages yellow. Apical ventral angle of segments 3-7 with a small black spot. (Hamulos, fig. 179.)

Female.—Colored similarly to male except that the markings are heavier and approach the markings of *morrisoni*. The lateral abdominal stripe is present on the anterior end of segment 3.



FIGS. 186-191.—*OPHIOGOMPHUS SEVERUS MONTANUS*. 186. COLOR PATTERN. 187. HAMULES. 188-189. MALE, APPENDAGES. 190. VULVA. 191. FEMALE, OCCIPUT.
FIGS. 192-197.—*OPHIOGOMPHUS SEVERUS*.
FIGS. 198-203.—*OPHIOGOMPHUS ARIZONICUS*.

Abdomen, male, 37-39 mm.; female, 40-41; hind wing, male, 30-37 mm.; female, 35-38.

I have five males and one female of this species from the lower end of Truckee River where it flows through the desert just before entering Pyramid Lake. One male and three females were taken on the Humboldt River at Carlin, Nevada. All the specimens were taken on gravel bars near rapids. The habits were similar to those of *bison* and *severus*. These desert specimens agree in their large size and ashy coloration, but structurally no character seems to separate them from *morrisoni*. The usual types of appendages found in *morrisoni* are shown in figures 172-173, but an occasional *morrisoni* regular in color and size has appendages as shown in figure 177, where the superiors are more pointed and the inferior is shorter than the superiors. The usual forms of appendages of *nevadensis* are shown in figures 180-181, but one *nevadensis* male, regular in size and coloration, has appendages as in figure 185, with the inferiors distinctly longer than the superiors. Neither are the forms of hamules and seminal vesicle constant. This variety then differs from *morrisoni* in the larger size and paler coloration, and from *severus* in having pointed posterior hamules.¹ (Fig. 182, vulva; 183, female occiput.)

OPHIOGOMPHUS ARIZONICUS, new species.

Type.—Cat. No. 21142, U.S.N.M. A male, Huachuca Mountains, Arizona, F. H. Snow.

Allotype.—Cat. No. 21142, U.S.N.M. A female, Huachuca Mountains, Arizona, F. H. Snow.

Color in dried specimens, Male.—Thorax and abdominal segments 1 and 2 olive, abdomen yellow, markings black. (See fig. 198.)

Face greenish yellow; eyes brown (probably gray in life); a black line, interrupted medially, on the posterior edge of the horizontal surface of the frons; vertex black, inclosing an oval pale area posterior to the ocelli; occiput pale; rear of head yellow, with a large T-shaped black marking. Prothorax largely black. Mesothorax and metathorax olive green (probably bright green in young live specimens), with dark brown markings as follows: A spot on upper end of middorsal keel, antealer ridges and upper third of humeral suture narrowly brown (in one male entire humeral suture brown). A small oval spot, or in one male a comma-shaped spot, on the upper end of the mesepisternum. Lower edge of mesepimeron black, pruinose. A small fleck anterior and one posterior to the lateral spiracle. Legs creamy; distal fourth of femur black, which extends mesad along the dorsal surface of the femur to the trochanter, this stripe broadest on the fore legs; tibiae black with an external pale stripe; tarsi black.

¹ I thought at first that this was a distinct species, as I found a single exuvia on the Truckee River undoubtedly of this species and differing markedly from those of *morrisoni*. However, I found *nevadensis* common on Owens River in eastern California during August, 1915, and setted up several nymphs which are almost identical with those of *morrisoni*. See p. 549, footnote.

Abdomen with segments 1 and 2 olivaceous; segments 3-10 yellow on dorsal surface, and segments 7-10 yellow on the sides also. Probably the sides of segments 3-6 are white in life. The markings on the abdomen are as follows: Segment 1 with a large brown spot above on either side; segments 2-10 with the usual ophiogomphine saw-toothed band on either side, but the teeth of the two bands are broadly connected across the posterior end of segments 3-7 and connected, but more narrowly, across the ends of segments 2 and 7-9. In two of the males there is a small pale brown spot on the upper side of segment 10; in the third the lateral band is continuous to the bases of the dorsal appendages, but on segment 10 is a paler brown. Appendages yellow.

Female.—Color similar to that of the male but the posterior half of vertex pale; tips of occipital horns black. Abdominal black pattern similar to that of the male, but the teeth of the lateral bands broadly connected across the apical end of segments 8 and 9 as well as on segments 3-7. Appendages yellow.

Abdomen, male, 40 mm.; female, 42; hind wing, male, 34 mm.; female, 37.

This species was called to my attention by Mr. E. B. Williamson, who had obtained two males and two females in trade from the Snow collection at the Kansas State University of Lawrence, Kansas. Later I obtained through Mr. Hunter three males and a female from the same collection. All of these specimens were wrongly labeled *Ophiogomphus severus*. The three males in my collection are labelled "S. Arizona, F. H. Snow, Aug., 1902." The female is labelled "Oak Creek Canon, Ariz., 6,000 ft., Aug., F. H. Snow." I have associated the female with the two males because it was so associated in the Snow collection, and because of identity of size and color pattern and the occiput, which seems adapted to the male's inferior appendage.

Structurally this species is distinguished as follows: Size large, male superior appendages 2 mm. in length, subcylindrical, slightly curved ventrad and mesad so that they are convex on the external profile and concave on the inner; the apical end suddenly contracted to a well developed point. The inferior profile from the base of the appendages to the base of the terminal point is an almost straight line, though slightly sinuous in one specimen. The distal two-thirds of the lower surface bears between thirty and forty short conical, black spines. Except in the greater number of spines the superior appendages do not differ from those of *severus*. The inferior appendage is one of the distinguishing characters of the species. It is peculiar in being only half the length of the superiors. Viewed from above it is bifurcate to the basal third, the two branches meeting apically around an oval opening. Viewed laterally the ventral profile is a semicircle, while the dorsal profile is a nearly straight line slightly

indented near the base of the appendage. Each branch terminates in a short, heavy, black spine directed dorsad. (See figs. 200, 201.)

Anterior hamules spatulate, spoon shaped with a long ventral hook (see fig. 199). One male shows a small spine on the tip of this hook. This apical spine is an individual character, some individuals of other species showing it. Posterior hamules terminating in a straight thin limb with subparallel sides and a square tip. The hamules are similar to those of *bison* and *severus*, from either of which the male can be distinguished by the terminal appendages.

The female is distinguished by having two very short, heavy, widely spaced spines on posterior edge of occiput (fig. 203) and a deep semi-circular depression on its superior surface. Probably this depression, which is peculiar to the female of this species, is to adjust the occiput to the extremely short inferior appendage of the male. (Vulva, fig. 202.)

OPHIOGOMPHUS BISON *Selys*.

Live colors, male.—Thorax rich green; abdomen yellow with black markings. (See fig. 164.)

Face pale greenish yellow; eyes gray; vertex entirely black, this color extending onto the posterior edge of the frons; occiput yellow.

Thorax a rich bright green with the following dark brown markings: A middorsal stripe 1 mm. wide connecting along the antealar ridge with a broad (1.5 mm.) usually solid humeral stripe. (In some specimens the humeral stripe has a very narrow internal green line.) The latero-alar ridge brown caudad to the second lateral suture, which is narrowly brown. The mesinfraepisternum and metinfraepisternum as well as the prothorax heavily mottled with black and usually pruinose. Femora with a heavy external (dorsal) black stripe; tibiae and feet black. Costa edged with yellow. Wings heavily veined and with a slight flavesence. Pterostigmas black.

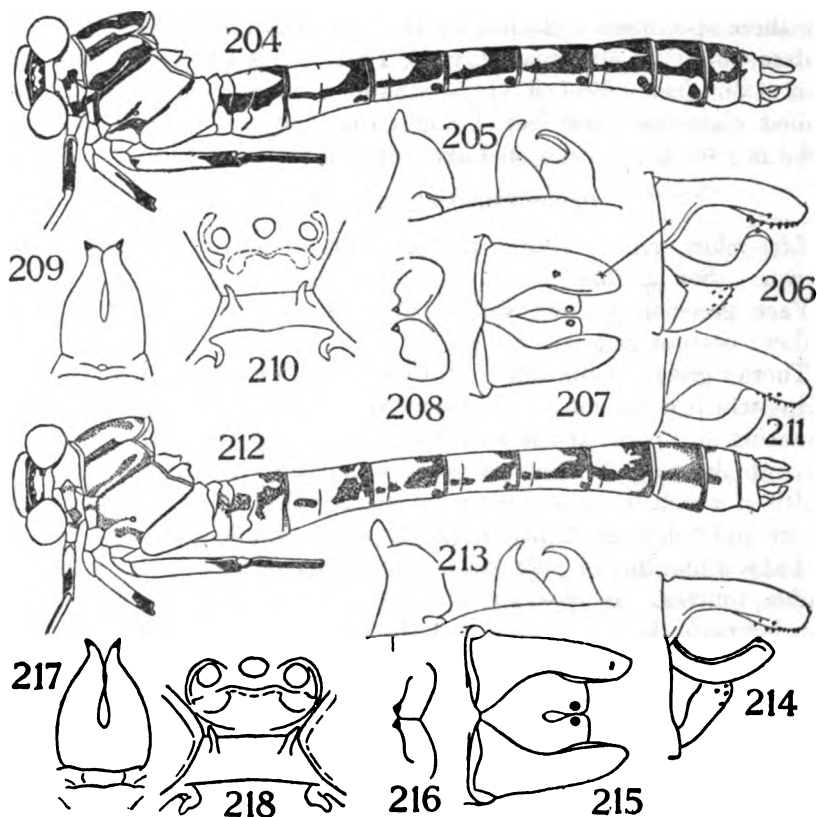
Abdomen bright yellow above the black lateral markings and white below. The black markings are as follows: A broad stripe extending along the upper side of segments 1 and 2, and converging to the dorsal apex of segment 2; a narrower lateral stripe (1 mm. wide) extending along sides of segments 2–10 (pale brown on 9 and 10). This stripe has a rectangular enlargement at the apical end of each segment. These enlargements do not coalesce with their fellows of the opposite side on the middorsal line except at the extreme apex of each segment, and on segments 9 and 10 they are widely open on the middorsal line at the apex. Segments 3–8 with a spot in the postero-ventral angle. (For structural details, see figs. 165–167.)

Female.—Colored like the male but the postocellar region of the vertex yellow. Femora usually with only the outer half in the first pair and the outer fourth in the others black; tibiae with an external pale stripe. Segment 9 of the abdomen less heavily marked than in the male, and segment 10 yellow. (Structural details, figs. 168–169.)

The thorax in this species is covered with pile which softens the intense colors.

Abdomen, male, 36-37 mm.; female, 35-38; hind wing, male, 29-30 mm.; female, 31-31.5.

This species occurs on the smaller perennial streams emptying into San Francisco Bay and Monterey Bay, also on the smaller tributaries



FIGS. 204-211.—*OPHIOGOMPHUS OCCIDENTIS*. 204. COLOR PATTERN. 205. HAMULES. 206-208. MALE, APPENDAGES. 209. VULVA. 210. FEMALE, OCCIPUT. 211. APPENDAGES OF A MALE FROM CORVALLIS, OREGON.

FIGS. 212-218.—*OPHIOGOMPHUS OCCIDENTIS CALIFORNICUS*.

of the Sacramento River. On the Sacramento itself and its larger tributaries it appears to be displaced by *Ophiogomphus occidentalis*. I have not found it on streams which carry much snow water. It is found on the same streams that are occupied by *Octogomphus*, but the latter stays on the torrential headwaters while *bison* occupies the low-land sluggish portion of the stream, where it is associated with *Gomphus sobrinus* and *Progomphus borealis*.

Its habits are very similar to those of *severus* and *nevadensis*. It is usually found on gravel bars bordering a riffle and seldom more than five or six are found at one place. The females oviposit where the water is the swiftest.

My own records and those in the Stanford collection and in Mr. Grinnell's collection are all for May and June. The records are for Chico, Butte County; Napa River, Napa County; Oroville in an irrigation ditch; Walnut Creek, Contra Costa County; Los Gatos and Stevens Creek, Santa Clara County; San Lorenzo River, Santa Cruz County. This last is Selys's type locality.

Miss Butler has described this species as *sequoiarum*.¹ Her types are three specimens collected by Dr. J. C. Bradley at Three Rivers, Tulare County, California, July 16, 1907. This place has an elevation of 500 feet. Prof. J. G. Needham² records nymphs from Lake Tahoe, elevation 6,000 feet; I doubt that they are correctly labeled. I did not see this species on Lake Tahoe myself.

OPHIOGOMPHUS OCCIDENTIS Hagen.

Live colors, male.—Thorax green, abdomen yellow, markings dark brown. (See fig. 204.)

Face greenish yellow; vertex black with the postocellar ridge yellow; occiput yellow; eyes gray.

Thorax green on the sides, whitish below, with a middorsal brown stripe which is 1.5 mm. wide below and narrower above, or even terminating in a point at the antealar sinus. Only the extreme edge of the antealar ridge brown. A broad humeral stripe three-fourths the width of which lies anterior to the suture; this stripe, 1.5 mm. wide above and below, is slightly narrower in its middle third and usually includes a fine line of pale green running lengthwise through its two middle fourths. In most specimens a narrow (0.25 mm.) pale brown line between the front wing and the mesepimeron, also one on the second lateral suture which extends down around the metinfraepisternum. Legs grayish white with an external (dorsal) black stripe the entire length of the femur of the first pair and only on the distal half of the second and third femora; tibiae black with an external white stripe; tarsi black. Costa yellow; pterostigmas dark gray to brown.

Abdomen rich yellow dorsally and on sides of segments 7–10, but white on the sides of segments 1–6 below the black markings. These markings are as follows: A band 1.5 mm. wide on the upper half of side of segment 1 running caudad and meeting its mate of the other side at the dorsal apex of segment 2. A small spot posterior to auricle. A lateral black stripe about 1 mm. wide extending from segments 3–9; on the apical third of each segment it widens dorsad, extending to the middorsal line at the apex of the segment. A black spot on the ventro-apical angle of the side of each of segments 3–8. Segment 10 and appendages largely yellow.

Female colored much like the male, but the lateral stripe on the abdomen narrower and more broken, and the apical dorsal extensions narrower. (Structural details: Male, figs. 205–208; female, 209–210.)

¹ Can. Ent., vol. 46, 1914, p. 346.

² Proc. U. S. Nat. Mus., vol. 37, 1904, p. 690.

This species resembles *bison* in appearance but is less intensely colored and does not have the black pruinose infraepisterna, which distinguishes *bison* from the other western species.

Abdomen, male, 35–38 mm.; female, 35–36; hind wing, male, 30–31 mm.; female, 33.

I found this species emerging in abundance from the Columbia River at Umatilla, Oregon, on July 10, 1913. I have one specimen from the Columbia at Sherman, Oregon, and two from Satus Creek, Yakima County, Washington. The specimens collected in the Sacramento basin show a lighter coloration than those from the Columbia Valley, and I have described them separately. One specimen of this dark form from Seattle, Washington, is in Calvert's collection in the museum of the Academy of Natural Sciences of Philadelphia.

The type of *phaleratus* Needham which I have examined appears to be this true *occidentis*. *Phaleratus* was taken on the Willamette River (a tributary of the Columbia) at Corvallis, Oregon. Figure 211 is of the appendages of a male from Corvallis.

OPHIOGOMPHUS OCCIDENTIS CALIFORNICUS, new variety.

Type.—Cat. No. 21144, U.S.N.M. A male, American River, Sacramento, California, July 15, 1914.

Allotype.—Cat. No. 21144, U.S.N. M. A female, American River, Auburn, California, July, 19, 1914.

Colors, male.—Yellow with brown markings. (See fig. 212.)

Face pale yellow, the frons narrowly edged behind with black; vertex black but with a large postocellar area yellow; occiput yellow; eyes gray, darker above.

Thorax yellow with a greenish cast. Markings as in *occidentis*, but pale brown and much reduced in extent. A narrow brown mid-dorsal stripe but antealar ridges yellow. Humeral stripe double, but both lines narrow and separated by a distance equal to one of them. Second lateral suture with a mere suggestion of brown. Faint markings along the lower side of the thorax. Legs creamy white; femora tipped with black; tibiae black with an external pale stripe; tarsi black. Costa yellow, pterostigmas dark brown; venation brownish but the wings otherwise hyaline.

Abdomen yellow with brown markings except below the markings on segments 3–6, which area is white. The sawtoothed lateral stripe is reduced to a series of spots and is not broadly connected with its fellow across the posterior ends of the segments 3–6, as in *occidentis*. Segment 10 wholly yellow and only a trace of brown on segment 9.

Female.—Color as in male but segments 1 and 2 almost wholly yellow, and on segments 3–8 the lateral stripe more nearly continuous than in the male. Segment 9 yellow except a black speck on apical end of the middorsal line. Segment 10 and appendages yellow.

Abdomen, male, 35.5 mm.; female, 37.5–38; hind wing, male, 28 mm.; female, 30.5–32. (Structural details, figs. 213–218.)

I have a male taken on the Sacramento River at Colusa, a male from the American River at Sacramento City, and three females from the American River at Auburn. In structure these are undoubtedly *occidentis*, but in color they are very much lighter than the *occidentis* of Umatilla and Satus Creeks in the Columbia Valley.

The Colusa male was taken June 11, while the other male was caught July 15, 1914, in the willow thicket across the American River from the city of Sacramento and was the only *Ophiogomphus* seen at this point. The three females were caught July 19, 1914, among the rocks below the dam in the American River Canyon at Auburn, California, where only one other specimen was seen.

11. THE NYMPHS OF OPHIOGOMPHUS.

The following generic characterization of the *Ophiogomphus* nymph is given by Needham in The Dragon Flies of Illinois:¹

Nymph stout, little flattened. Head abruptly sloping forward from the ocelli. Labrum pilot-shaped. Antennae with the two basal segments globular, third segment twice as long as both basal, much flattened and laid close beside the labrum. Fourth joint a minute rudiment. Median lobe of mentum rounded, with border of short blunt teeth and a double series of fringing scales. Lateral lobes nearly straight, not terminating in an end hook and minutely denticulated within; movable hook short, arcuate.

Legs rather short. Fore and middle tibiae with external hooks, wing-cases divaricate, strongly sloping downward toward the sides. Dorsal hooks on abdominal segments on 2 or 3–9. Tenth segment not inclosed by the 9th but triquetral, exceeding the lateral spines, its own lateral margin forming a part of the margin of the abdomen.²

The nymphs of the western species of this genus are separated from one another with considerable difficulty. Figures 224, 227, 230, 233 and 236 show labia of the five species, which, as with any other single character of the nymphs, vary too little to be of any use in separating the species. The dorsal spines are also practically the same in all species. The characters used in the following notes are the only ones I have found to be of value.

KEY TO NYMPHS.

a¹. Segments 6–9 with lateral spines.

b¹. Superior appendages three-fourths length of median appendage; dorsal hooks strong.....*bison*.

b². Superior appendages two-thirds length of median appendage; dorsal hooks heavy but low, only those on segments 2–4 erect.....*occidentis* and *o. californicus*.

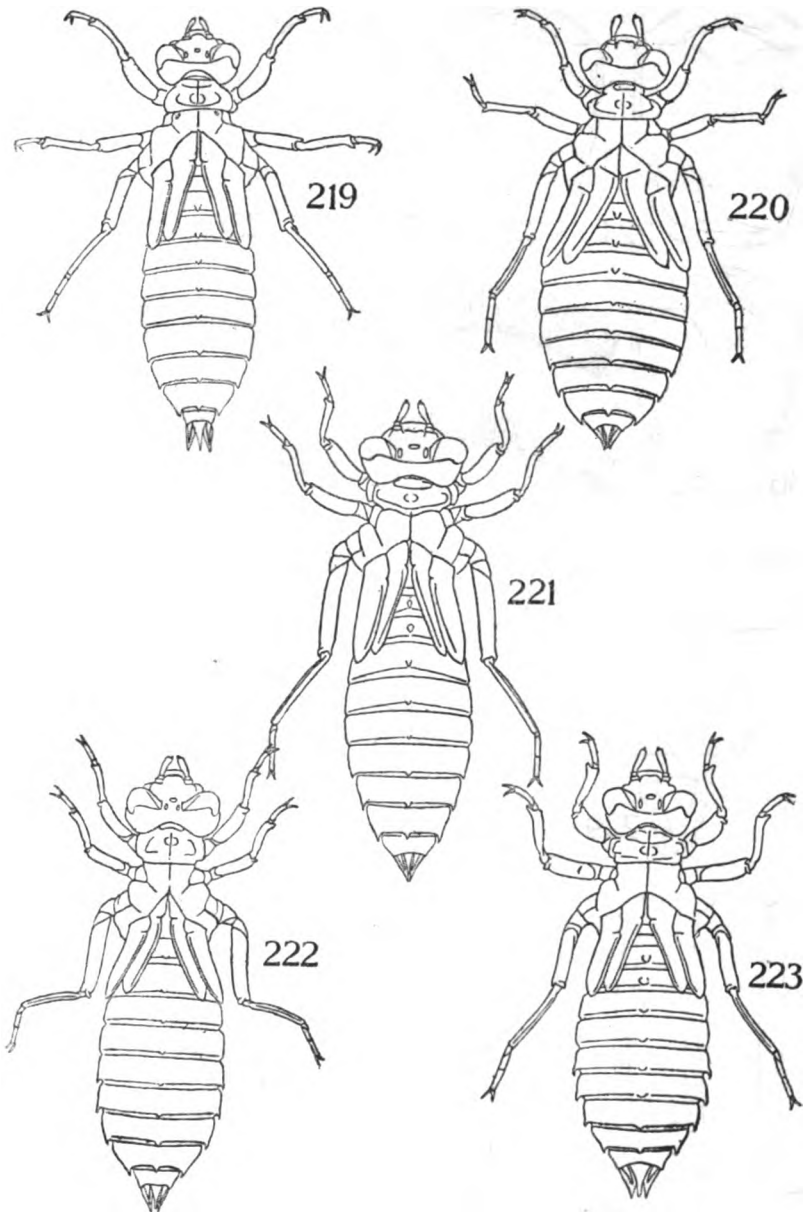
a². Segments 7–9 with lateral spines.

c¹. Dorsal spines weak and low, only the first two or three erect.....*severus*.

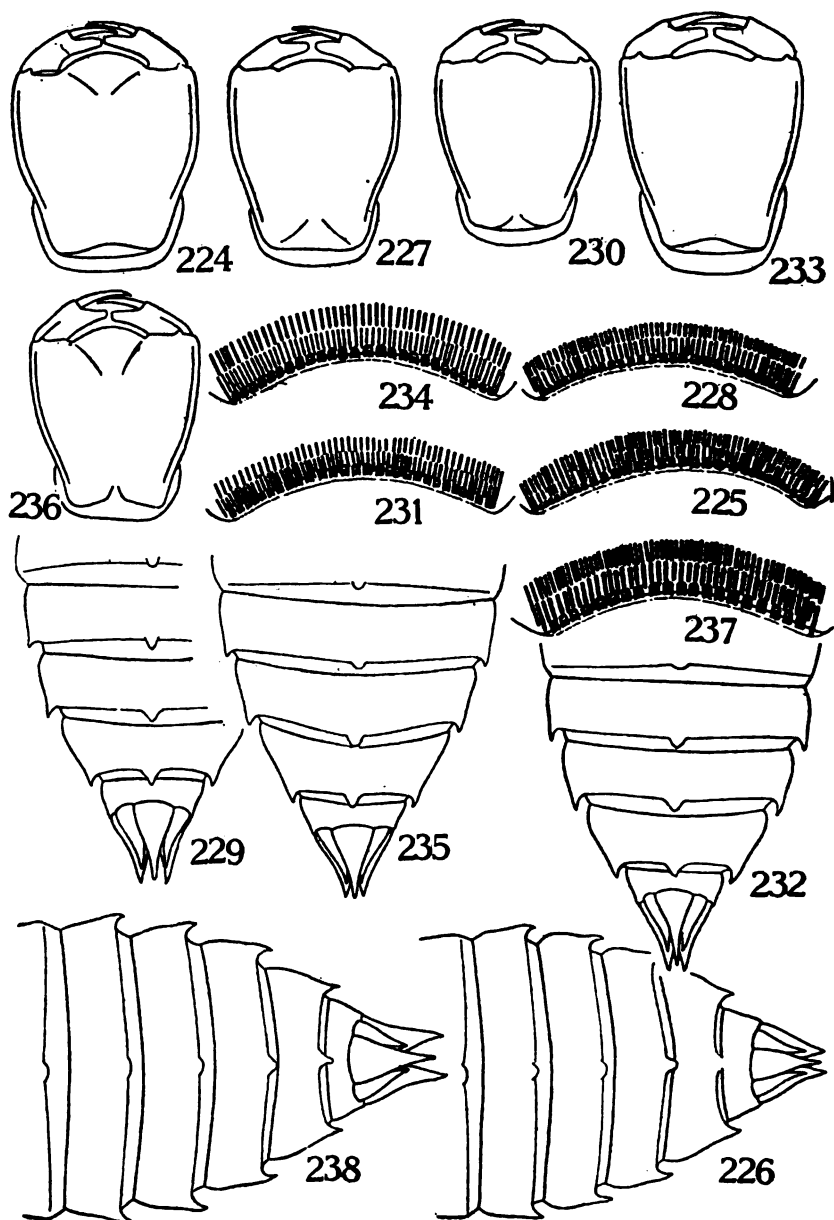
c². Dorsal spines slender, erect, well developed.....*morrisoni* and *m. nevadensis*.

¹ Bull. Ill. State Lab. Nat. Hist., vol. 6, art. 1, 1901, p. 57.

² The nymphs of *Erpetogomphus* are distinguished by dorsal spines on segments 2–4 only. I have examined nymphs of *compositus*, *designatus*, and an undescribed species.



FIGS. 219-223.—*OPHIOGOMPHUS* NYMPHS. 219. *O. MORRISONI*. 220. *O. SEVERUS*. 221. *O. MORRISONI NEVADENSIS*. 222. *O. BISON*. 223. *O. OCCIDENTIS*.



FIGS. 224-226.—*OPHIOGOMPHUS BISON*, NYMPH. 224. MENTUM. 225. TEETH AND SETAE ON MIDDLE LOBE OF MENTUM. 226. SEGMENTS 6-10.

FIGS. 227-229.—*OPHIOGOMPHUS MORRISONI*.

FIGS. 230-232.—*OPHIOGOMPHUS SEVERUS*.

FIGS. 233-235.—*OPHIOGOMPHUS MORRISONI NEVADENSIS*.

FIGS. 236-238.—*OPHIOGOMPHUS OCCIDENTIS*.

OPHIOGOMPHUS BISON Setya, nymph.

A dark, heavily mottled nymph, very hairy, in which character it resembles *morrisoni*; 27–33 labial teeth, those at either end of the row being only half as long as the median teeth. Abdomen with the dorsal hooks on segments 2–9 longer than in the other species¹ and heavier; lateral hooks on segments 6–9. The paired superior appendages three-fourths the length of the median appendage. (See figs. 222, 224–226, and 239.)

Length, 28–29 mm.; abdomen, 17.5; hind femur, 4.5; width of abdomen, 8.5–9.

The above description is from exuviae collected on the San Lorenzo River near Santa Cruz, which is the type locality for the imago of the species. I have not taken this emerging, but no other species was collected on this stream and these exuviae agree with exuviae I have collected at Chico, where *bison* was on the wing. Needham's description of nymphs and exuviae collected by Schwarz on Lake Tahoe fits my exuviae of *bison*, but I found *morrisoni* on Lake Tahoe and only *morrisoni* in the Tahoe region. I believe the locality given is a mistake. *Morrisoni* is a species of the cool upper limit of gomphine life occurring at from 4,000 to 10,000 feet elevation, while all my records for *bison* are from the low hot valleys of central California.

OPHIOGOMPHUS OCCIDENTIS Hagen, nymph.

A medium colored nymph; a lengthwise row of small light spots along either side of the dorsum of the abdomen. Only moderately hirsute, more hairy than the *nevadensis* exuvia from Winnemucca Slough, but less so than *severus*; 21–25 labial teeth which are equal in length throughout the row. Abdomen with dorsal hooks on segments 2–9, these noticeably variable in height and strength, but usually with the first hook slender, erect, the remainder short and heavy. Lateral hooks on segments 6–9. The paired superior appendages two-thirds the length of the median appendage. (See figs. 223, 236–238, and 240.)

Length, 28 mm.; abdomen, 18; hind femur, 4.5; width of abdomen, 8–8.5.

The above description is from exuviae collected on the Columbia River at Umatilla, Oregon. I am sure of the identity of this, though I took none actually emerging.

OPHIOGOMPHUS OCCIDENTIS CALIFORNICUS Kennedy, nymph.

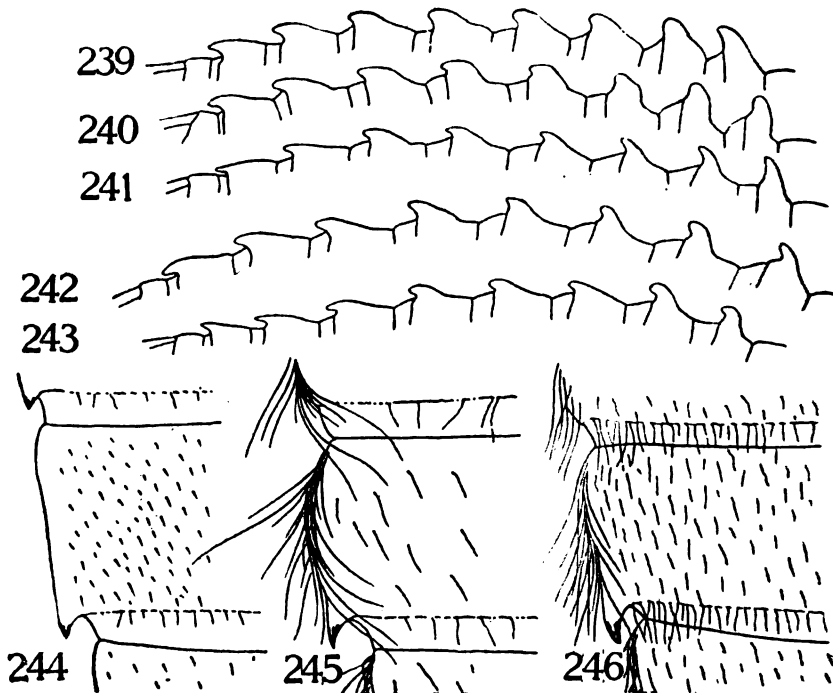
I have eight *occidentis* exuviae from the American River at Sacramento, California. These are probably of the yellow variety, *californicus*, but I can see no characters separating them from the *occidentis* nymphs of the Columbia River. In these the lateral ab-

¹ Not longer than in *morrisoni* and *montanus*, but in these they are slender.

dominal spines are very variable in length, some being short and blunt, others unusually long. Such variations occur even on the individual. In one the spines on segment 6 are blunt, on segments 7-9 long and pointed.

OPHIOGOMPHUS SEVERUS Hagen, nymph.

A medium colored nymph, only moderately hairy; 26-29 labial teeth. Abdomen with dorsal hooks on segments 2-9, low and weak.



FIGS. 239-243.—*OPHIOGOMPHUS*, DORSAL SPINES OF NYMPHS. 239. *O. BISON*. 240. *O. OCCIDENTIS*. 241. *O. MORRISONI*. 242. *O. MORRISONI NEVADENSIS*. 243. *O. SEVERUS*.

FIGS. 244-246.—*OPHIOGOMPHUS*, LATERAL FRINGE ON SEGMENT 7 OF NYMPH. 244. *O. MORRISONI NEVADENSIS*. 245. *O. SEVERUS*. 246. *O. MORRISONI*.

Lateral hooks on segments 7-9. The paired superior appendages four-fifths as long as the median appendage. (See figs. 220, 230-232, 243 and 245.)

Length, 28 mm.; abdomen, 19; hind femur, 4.75; width of abdomen, 8.

Described from exuviae collected on Satus Creek, Yakima County, Washington. I have specimens of this taken emerging.

OPHIOGOMPHUS MORRISONI Selys, nymph.

A medium to dark nymph, very hairy; each abdominal segment on its dorsal aspect fringed posteriorly with numerous long hairs; 25-29 labial teeth. Abdomen with dorsal hooks on segments 2-9, these longer and more erect and more slender than in other species,

except *nevadensis*, which they resemble, but not differing enough to make a positive specific character. Lateral hooks on segments 7-9. The paired superior appendages four-fifths as long as the median appendage. (See figs. 219, 227-229, 241 and 246.)

Length, 28 mm.; abdomen, 18; hind femur, 5; width of abdomen, 8.

Described from numerous emerging nymphs and exuviae collected on Donner Lake, July 23, 1914.

OPHIOGOMPHUS MORRISONI NEVADENSIS Kennedy, nymph.

A large light colored nymph, naked except for a few short hairs on the tibiae and about the head; 26 labial teeth. Abdomen with dorsal hooks on segments 2-9, longer, more slender, and more erect than in other species except *morrisoni*. Lateral hooks on segments 7-9. The paired superior appendages four-fifths as long as the median appendage. (See figs. 221, 233-235, 242 and 244.)

Length, 31 mm.; abdomen, 20; hind femur, 5.5; width of abdomen, 8.5.

Described from a single male exuvia collected on Winnemucca Slough at Pyramid Lake, August, 1914. The only other gomphine found at this place, which is a branch outlet of the Truckee River, was *Erpetogomphus compositus*. This is not the nymph of that.¹

OPHIOGOMPHUS, species.

In the Cornell collection are five dried nymphs from "N. Mex." These are very close to *severus*, but differ in having the dorsal spines noticeably weaker, and only the spine on segment 2 erect, those on segments 3-9 pointing caudad.

Severus is recorded by Selys² from the Merino Valley (elevation, 9,600 feet), New Mexico. I have seen no specimens of imagoes from New Mexico. Selys records the Merino Valley as on the Colorado. If so, this may be the nymph of *arizonicus*.

12. THE WESTERN SPECIES OF GOMPHUS, INCLUDING A NEW SPECIES AND A NEW VARIETY.

I feel fairly certain that future collecting and study of intermountain and Pacific coast species of the genus *Gomphus* will show that there are only three good species.³ These are *intricatus*, *olivaceus*, and *confraternus*. *Intricatus* apparently does not break into varieties. It is recorded from the upper Rio Grande Basin northwest to the Humboldt River in Nevada and west to the Owens River in southeastern

¹ In August, 1915, I collected several *Ophiogomphus* nymphs while seining for fish in Owens River, Inyo County, California. As only *Ophiogomphus morrisoni nevadensis* was taken in Owens River these were probably that species. These were much more hairy than the exuvia described above but hardly as hairy as *morrisoni* exuviae from Donner Lake. Finding these Owens River nymphs made me decide that *morrisoni* and *nevadensis* are forms of the same species.

² Bull. Acad. Belg. (2), vol. 46, 1878, p. 26.

³ Since the above was written a single male of *Gomphus grasilinellus* Walsh was found in the Carnegie Museum of Pittsburgh, which had been caught on Lake Neumon, Washington. Dr. J. G. Needham states that among his notes is a second record of *grasilinellus* from Washington, which he had considered an error.

California. *Olivaceus* is recorded from the San Joaquin River east to the Humboldt and Owens Rivers and north to the British Columbia portion of the Columbia River. I have not examined the British Columbia specimens, but the Humboldt River form is paler in color than the Owens River and Central California form. The species thus breaks into at least two varieties. The situation with *confraternus* is even more complicated. I have not seen the California form called *confraternus* by Salys. From my study of Coast *Gomphus* I believe that *sobrinus*, *donneri* (see pp. 562-570), and the form from Seattle, Washington, called *confraternus* by Osborn¹ will be found to intergrade with this California *confraternus* of Salys, which has not yet been rediscovered. The name which will have to be used for this group of varieties will have to be *confraternus* because of priority.

In the following pages I have considered *donneri* and *sobrinus* as distinct species because I do not have material that absolutely connects them.

Olivaceus and *intricatus* are species of warm, muddy and sluggish rivers. The "*confraternus* group" have more diversified environments. *Sobrinus* of this group is found in the small sluggish streams of Central California. *Donneri* is from the cool clear mountain lake whose name it bears, while the form from Seattle, Washington, called *confraternus* by Osborn (see p. 565) was taken on Lake Washington, a lake of clear water that never freezes.

The forms of the *confraternus* group do not fall into any of the subgenera established by Dr. J. G. Needham on nymphal characters. See pages 570-571 for descriptions of nymphs.

GOMPHUS INTRICATUS Hagen.

I first found this small yellow *Gomphus* on the Humboldt River at Golconda, Nevada, on August 7. Late in the afternoon after a day of ordinary collecting around the hot springs and through the willow thickets of the river bottoms, I caught a male and four female *Gomphus* on the bank of the river. Seeing that they were strange to me but not noticing them closely I took them for a single species. In the evening I went by train to Winnemucca and that night, when papering my day's catch, I decided that the male and two of the females were one species, while the other two females were of another species, of which I had no males. The following day I collected along the Humboldt at Winnemucca and caught a good series of the larger species of which I had a male from Golconda, but did not see a single specimen of the smaller species of which I had but two females.

Not knowing where I might again take the small species, except at Golconda, I boarded the afternoon train and went back, spending the next day collecting again around Golconda. I made a painstaking search among the willows for *Gomphus* and took several of the

¹ Ent. News, vol. 16, 1905, p. 189.

larger species, but until late in the afternoon saw only two of the small species and these females, both of which were wild and unap-



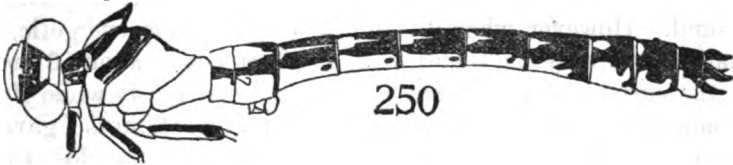
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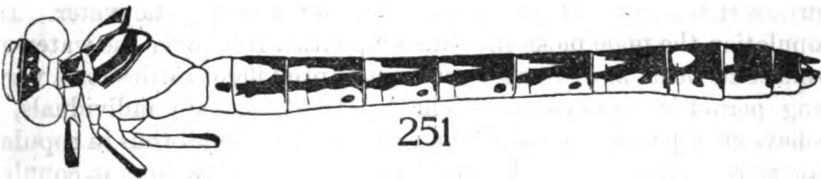
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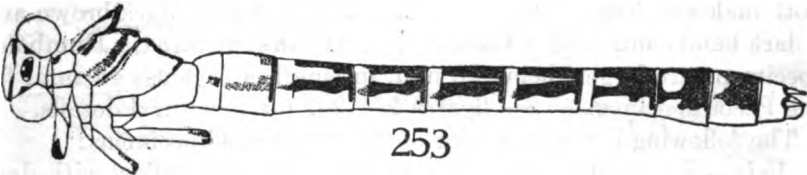
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FIGS. 247-249.—*GOMPHUS INTRICATUS*.

FIGS. 250-251.—*GOMPHUS OLIVACEUS*.

FIGS. 252-253.—*GOMPHUS OLIVACEUS NEVADENSIS*.

proachable. But about four o'clock in the afternoon I flushed a male of the small species from a clump of rose bushes and with that suspense, which comes to a collector perhaps once a season as he sees a

prize of prizes flying away, waited several very long moments, while he decided whether to alight or to fly across the river out of my reach. Indifferent to danger, he lit on my side of the river but in the safest place possible as he chose a bare patch of ground in the midst of a broad area of salt grass. As salt grass at its best is only six inches high there was no cover whatever to aid in stalking him. Resorting to the only tactics available I very slowly approached him on my hands and knees and was greatly relieved when I got close enough to see that he, still unmindful of his danger, was busily engaged in scratching his head with his foot. I was more relieved when a moment later I had the net over him, but the suspense was not entirely relieved until I had him in a cyanide bottle and the cork in tight.

That night I took the train down the river to Lovelocks, the last town before the river spread out into the Humboldt Lakes. Here the following day along the river two miles east of town I found both species of *Gomphus* abundant and took a series of the small species as well as several of its exuviae.

As with most species of *Gomphus* this species spends much of its time seated on some bush or piece of driftwood, rarely alighting on the ground. However, when it is on the wing it is very energetic, and the males fly rapidly back and forth in short beats, about 6 inches above the surface of the water. The females oviposit while flying in the same quick, nervous manner. After many attempts I gave up trying to catch these over the water because they flew so close to the surface it was difficult to hit them without striking the water. In copulation the male picks the female up either from over the water or from some bush, and after a very short nuptial flight settles for a very long period in copulation. While I did not time any individuals, I believe such periods lasted an hour or more. Couples thus in copulation were so numerous and so preoccupied that I took more in copulation than single.

This species had been taken before only on the Pecos River,¹ in New Mexico. The only difference apparent between the Humboldt specimens and the description of *intricatus* is that in *intricatus* from the Pecos, the vertex is yellow,² while in all the Humboldt specimens, both male and female, the area about each antenna is dark brown and a dark band connects the three ocelli. Also in structure the Humboldt specimens are larger, being 50 mm. in length as against 45 mm. for the Pecos specimens. See figures 254-262 for structural details.

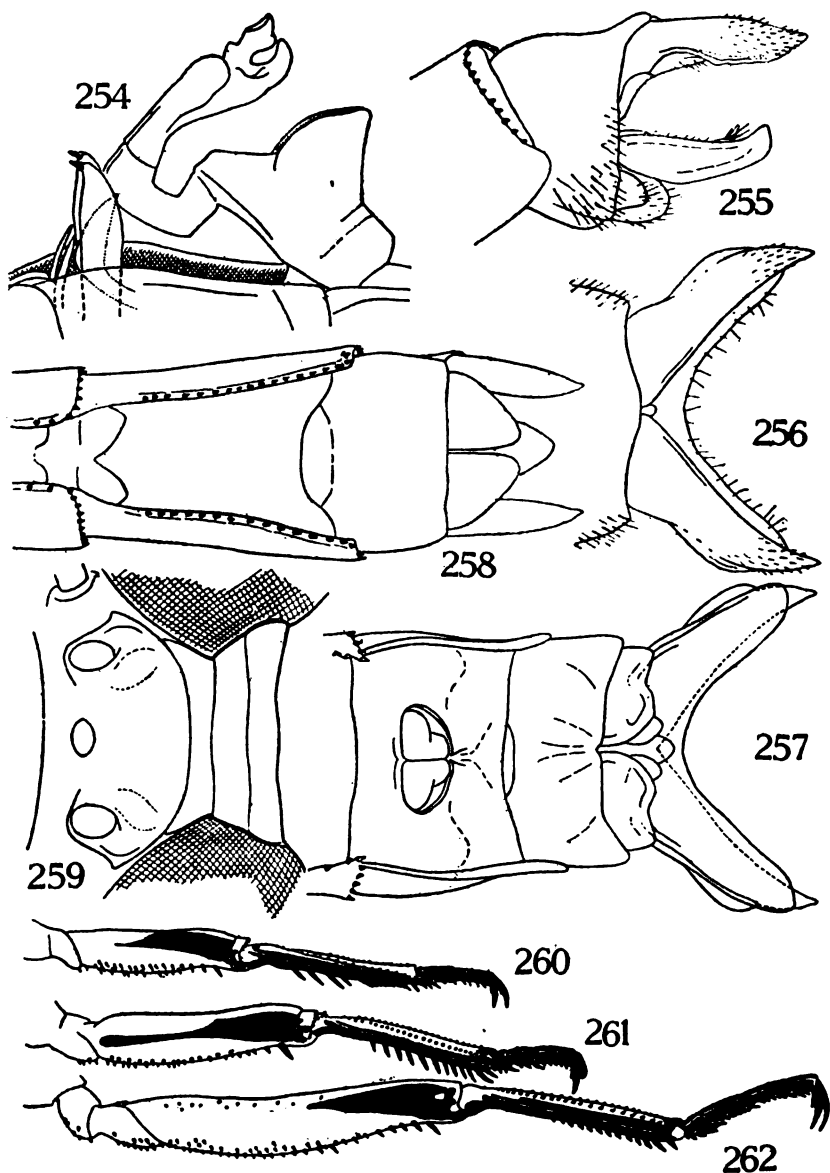
The following is the live color of the Humboldt specimens:

Male.—Face yellow, eyes pale gray, vertex olive yellow with dark brown about each antenna and a brown stripe connecting the three ocelli; occiput yellow. (See fig. 247.)

¹ Since writing this paper I have collected this species on the Owens River, in Inyo County, California, and have found a single male in the Cornell collection from Calaxico, California, collected by Dr. Bradley, Aug. 11, 1914. Calaxico is in the Imperial Valley.

² Selys, *Mon. Gomph.*, 1858, p. 678.

Prothorax yellowish olive with an H-mark above. Mesothorax and metathorax greenish yellow with brownish markings as follows: Antealar ridges, middorsal stripe (the yellow carina dividing it through



FIGS. 254-262.—*GOMPHUS INTRICATUS*. 254. MALE, SEGMENT 2. 255-257. MALE, SEGMENT 10. 258. SEGMENTS 9-10 OF FEMALE. 259. FEMALE, OCCIPUT. 260-262. MALE, LEFT LEGS.

its center), on either side a narrow incurved antehumeral stripe, which touches the antealar stripe above, but in seven of the nine specimens this fades out below. This dark antehumeral is separated by a yel-

low stripe slightly more than its width from a very narrow paler humeral stripe. A narrow pale spot on the lower end of the first lateral suture. Second lateral suture entirely brown. Wings with costa yellow; pterostigma yellowish, edged with dark brown. Legs yellow, a short antero-dorsal stripe on apical end of femur extending usually less than half its length; tibiae black, yellow externally; tarsi dark.

Abdomen with segments 1-6 greenish yellow and 7-10 deeper, pure yellow, markings black. Segment 1 with pale spot above on either side connected posteriorly with a pale stripe on segment 2, which stripe is darker in its posterior half. Apex of segments 2-6 with a narrow black ring. Each of 3-6 with a small spot posterior to the lateral carina and a large spot, covering two-fifths of the side, on the distal end of the segment. Segments 7-10 deep yellow, segment 7 marked similarly to segment 6, but the spots reduced in area and paler. Segment 8 with broad dorsal apical pale brown area. Superior appendages yellow with ventral apical face black. Inferior appendages yellow with tips black.

Female.—Similar to the male but segments 7-9 with distinct apical spots. Five of the nine females have the antehumeral stripes reaching the mesostigmal lamina. In three the narrow humeral stripe is so faint as to appear wanting. In four females segment 9 is entirely yellow. (See figs. 248-249.)

The following are the measurements of the 18 Humboldt specimens: Male, abdomen, 35-43 mm.; hind wing, 27-29; female, abdomen, 37-38 mm.; hind wing, 31-32.

I had the privilege of examining the following specimens of *Gomphus intricatus* which belong to the United States National Museum: Rio Grande River, Brewster County, Texas, Mitchell and Cushman, collectors, 1 male, 2 females; Albuquerque, New Mexico, Cockerall, 1 male; Chaves, New Mexico (P. P. Calvert), 1 female.

Except that the color pattern is slightly darker in the Rio Grande specimens, approaching almost to black, I can see no difference between the Rio Grande and Nevada series.

GOMPHUS OLIVACEUS Selys.

This is a large species found on warm muddy rivers. I have taken it in two places. On July 15 and 16 I took about 80 males and 6 females on the American River just below the Southern Pacific Railroad bridges at Sacramento. September 2 I took a single female on the dikes of the San Joaquin River at Stockton.¹

¹ Ferris took this on Bean Creek near Modesto, California (see p. 630), which is its present farthest south record in the San Joaquin Valley. In August, 1915, I found this dark form on Owens River, Inyo County, California. Kirby (Catalogue of Odonata, p. 65, 1890) records this from Nebraska. I do not know his authority. Walker (1st Rept. Ent. Soc. Ont., 1908, p. 120) records it from Paschland, British Columbia, which is in the Columbia River watershed. The exuviae recorded by Needham from Seattle, Washington, as *sobrinus* (Proc. U. S. Nat. Mus., vol. 28, p. 602) are of this species.

The specimens I took in Nevada I consider a distinct variety and will discuss them separately.¹

At Sacramento several miles of the American and Sacramento Rivers were explored, but this species was found only on the American River and was confined to that stretch just below the Southern Pacific bridge.

The river at this point was about 200 feet wide with sand bottom and sand shores except along the north shore at the deepest point, where it was 6 feet in depth and the steeper bank showed some clay. Later, in August, the water had fallen until it was only about 3 feet deep at this point. The shore here was bordered with cottonwoods, whose dark green tops rose above a line of paler willow bushes, which hung in the muddy water, while the river bottoms adjoining were an almost continuous thicket of box elder trees, about 30 feet high. In one or two places these box elder thickets thinned out and such glades were rank with grass and clumps of willows.

The males of *olivaceus* were abundant over the yellow river, where they flew leisurely in a broadly zigzag course at a distance of not more than 10 inches above its surface. At intervals they rested, usually in a hanging position, on the willows. The females were not much in evidence. Two were observed over the water and were swifter and more direct in their flight than the males. Several females were taken in the open willow glades back from the river. Here they rested on the bushes and weeds, sunning themselves. Here an occasional male wandered about apparently seeking a mate. When found the pair would fly away in a short nuptial flight, soon coming to rest on bushes where they remained in copulation indefinitely. Individuals were difficult to catch in these glades, because on being disturbed they would fly up out of reach. The large series was taken by wading breast deep in the river's edge and scooping them off of the willows. Much time was spent searching for exuviae, but none were found.

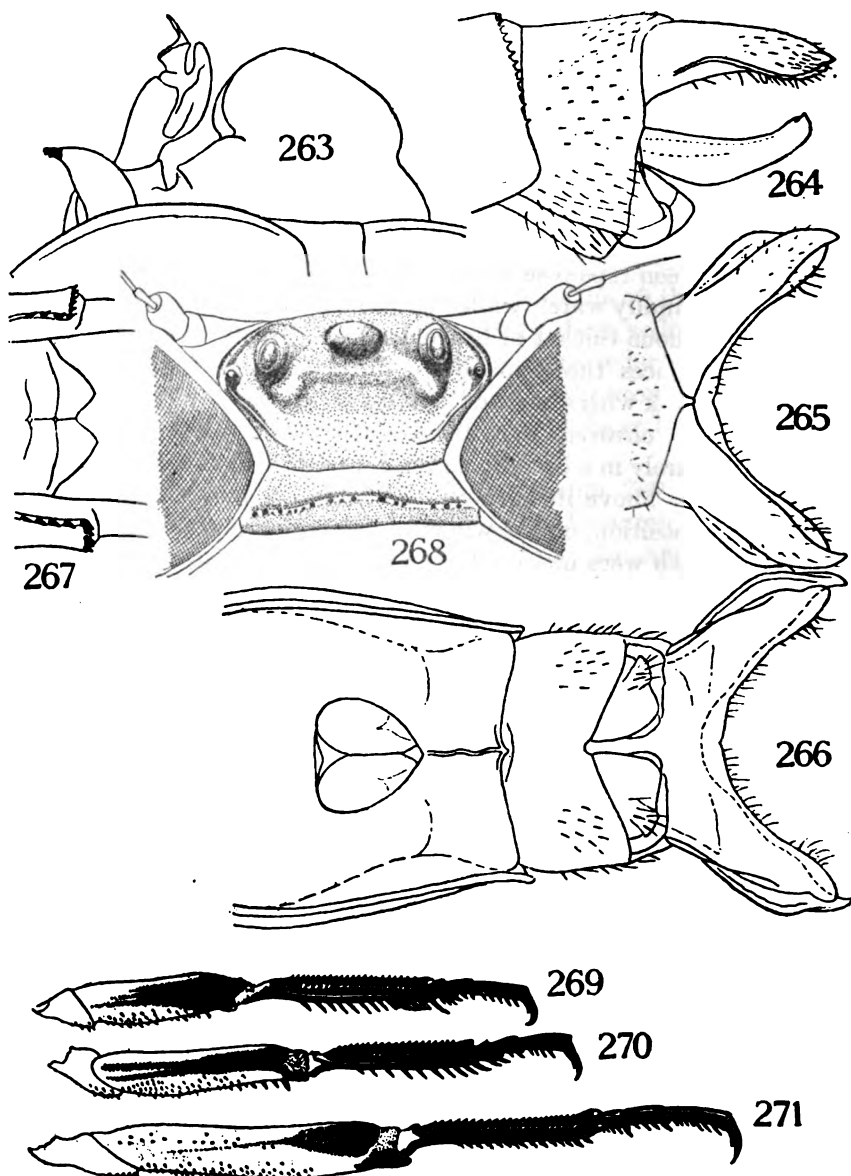
The illustrations (figs. 263–271) show the structural peculiarities of this species. The following is a description of the live colors:

Male.—Labrum pale grayish with greenish brown tints. Frons slightly browner than labrum, but paler except for a black band across its posterior edge. Vertex black except posterior to the ocelli, which with the occiput is pale grayish brown. Eyes blue, paler below. Postocular area pale brownish gray, shading into a bluish gray above. (See fig. 250.)

Prothorax dark brown except the anterior lobe which is yellow. Mesothorax with a black middorsal stripe twice as wide below as at the antealar sinus. Antealar sinus brown, connecting the middorsal stripe with the very wide humeral suture. Usually included in this stripe is a gray hair line lying lying posterior to the suture and a slightly

¹ See p. 557 of this paper.

wider, more irregular and usually discontinuous gray line lying slightly in advance of the suture. The pale areas of the thorax are pale gray with a slight greenish tint except the infraepisterna,



FIGS. 263-271.—*GOMPHUS OLIVACEUS*. 263. MALE, SEGMENT 2. 264-266. MALE, SEGMENT 10. 267. VULVA. 268. FEMALE, OCCIPUT. 269-271. MALE, LEFT LEGS.

which are yellow. Legs with coxa and trochanter gray, femur gray with a broad dorsal black stripe, tibia and tarsus black. Wings with the costa edged with yellow, pterostigma brown.

Abdomen with segments 1-6 gray, and segments 7-10 creamy yellow, marked as follows: Segment 1 with a narrow black stripe above on either side which connects with a similar stripe on segment 2, on the latter segment the stripe widening caudad. Segments 2-7 each with a lateral stripe as in segment 2, and in the lower posterior angle of the side a spot, on segments 6 and 7 this spot usually connected with the stripe above. Intersegmental membranes of segments 7-10 yellow. Segment 7 with the lateral stripes meeting along the dorsal carina for the posterior two-thirds of its length. Segments 8 and 9 with the lateral stripes broadly united across the posterior end of each segment, leaving on segment 8 a round antero-dorsal spot one-half the segment's length in diameter and on segment 9 a more rectangular antero-dorsal pale spot one-third the length of the segment. Segments 8 and 9 edged below with black. Segment 10 black above, yellow on the sides. Appendages brown with black tips. This species is characterized by the continuous lateral stripes on the abdomen, the lateral spots on segments 3-7 and the general grayish color of the body.

The coloration of the female (fig. 251) is similar to that of the male.

The following are the measurements of 8 males and the 6 females of *olivaceus* taken at Sacramento:

Male, abdomen, 37-40 mm.; hind wing, 31-33; female, abdomen, 38-43 mm.; hind wing, 32-35.

GOMPHUS OLIVACEUS Selys, var. NEVADENSIS Kennedy.

This variety was first taken by Henshaw, whose specimens are probably in the Museum of Comparative Zoology. Hagen¹ lists these specimens as *olivaceus*.

I found this variety only in the Humboldt River, where I took it at Golconda, Nevada, August 7 and 9; Winnemucca, August 8; and Lovelocks, August 10. I did not find it in the swifter parts of the upper reaches of the river at Carlin.

From Golconda to Humboldt Sink, the Humboldt River is a muddy alkali stream, which meanders with many involved loops through this treeless valley. Its banks and bed are of alkali silt and it is bordered at every turn by dense thickets of gray willow, which are called pinwillows by the cowpunchers, because they seldom get larger than an inch in diameter. At this size they die and remain erect among the younger sprouts, making a thicket scarcely penetrable except by animal trails. The surrounding mountains are brown and bare and treeless, not even cottonwoods growing along this strange stream.

Both males and females were found most commonly in these willow thickets. They sunned themselves here, but every now and then one

¹ Rept. Surv. Terr. Colo., 1873, p. 397, 1874.

or more would apparently remember the river and would spend several minutes in a zigzag flight over its surface, returning shortly to rest again on the willows. Several pairs in copulation were seen flying about these thickets.

This variety, except for its slightly greater size, is identical with *olivaceus* of California in structure, but is readily distinguished, especially in fresh material, by the color, which is in general much lighter than in the California specimens. In the field I did not doubt that the two were distinct species, but was surprised when on my return I studied them under a binocular and could find no constant structural differences. The following are the live color notes:

Male.—Eyes blue, grayer below. General body color much more yellow than the California specimens, thus giving the Humboldt variety a lemon or gray yellow appearance, rather than the dark gray appearance of the former. Also all markings are more restricted and paler. Thoracic markings medium to light brown. Humeral stripe divided lengthwise into three distinct stripes by two inclosed pale stripes. In perhaps one-third of the material the humeral stripe fades out below. The black dorsal stripe on the femur reduced to a spot on the distal half or third. Pterostigmas in male and female pale gray yellow. In the abdominal markings segments 3–7 have a broad yellow basal ring. The lateral spots are absent except on segment 7, where they are much reduced in size. Segment 10 in male is mottled with brown above, and in the female is yellow, except for its brown dorso-caudal edge. (See figs. 252–253.)

Several exuviae, probably of this species, were found on the large salt grass sods lying in the edge of the water where the banks had been undermined. These will be described later. (See p. 570.)

The following are the measurements of 8 males and 7 females from Lovelocks: Male, abdomen, 40–42 mm.; hind wing, 33–34; female, abdomen, 40–43 mm.; hind wing, 34–36.

GOMPHUS SOBRINUS Selys.

Gomphus sobrinus has been known heretofore only from the type, a single male specimen "collected by Edwards in California" and later deposited in McLachlan's collection. This was described by Selys in the year 1873 in his Third Addition to the Synopsis of the Gomphines.

Except for the above specimen the species has remained unknown until this year. In April of this year I took a single specimen, a female, on Felt Pond on the Stanford campus, and in May I found it very abundant on Coyote Creek within the city limits of San Jose, where in a single day's collecting I succeeded in taking over 50 specimens, though much of the time was spent in endeavoring to catch *Macromia*. During the fore part of June I took several specimens

on one of the ponds on the Napa Insane Asylum grounds, and about June 15 caught several on Chico River east of the city of Chico.

Both Coyote Creek and Chico River are warm sluggish streams with mud banks and much mud bottom. On Coyote Creek on May 10 the species was at the height of its season. On May 27 it was much less abundant, and on July 4 it had entirely disappeared. On Chico River, June 14 and 15, only an occasional *sobrinus* was seen but the exuviae were very abundant, which would indicate that at that time their season was practically over. From the preceding data it is evident that *sobrinus* is an early spring species, appearing in April and gone by July, and that it inhabits the warmer constant streams of medium size and to a lesser extent ponds. Perhaps it is also limited to the more mud-bottomed streams, as I did not find it in the Feather, Yula, or American Rivers, which are sandy bottomed. Neither does it occur on clear spring-fed mountain streams, for one such flowed through the asylum grounds, and another (Stephen's Creek) flows not far from San Jose, in neither of which did *sobrinus* occur.

On Coyote Creek where I observed its habits more fully, it does not appear about the water in numbers until about 11 in the forenoon. Earlier than this it can be found on the sunny patches of bare ground back a few yards from the creek bank. It is active about the water during the heat of the day but leaves about 4 in the afternoon. The males are four or five times as abundant as the females, and usually stay low over the water, seldom rising higher than four or five feet above its surface. They usually rest on the bare sandy spots but light also on logs, brush and willows. The females oviposit by tapping the surface of the water with the abdomen at irregular intervals as they fly close over its surface. It is at such times that the males swoop on them and take them away in copulatory flights, which end in a long resting period in copulation on some tree or bush.

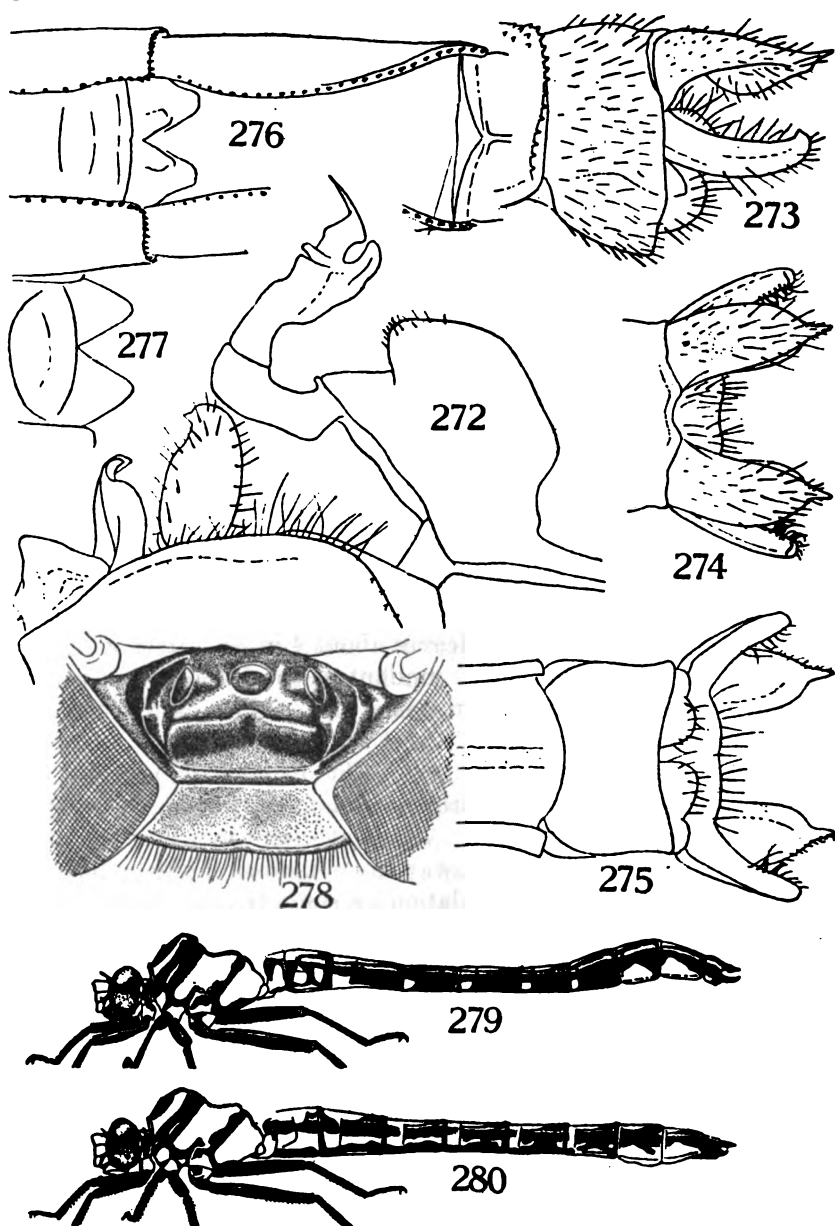
Many of the specimens which I have fit Selys's description closely, but the species varies in a remarkable way, and I believe on further study and wider collection will be found to include Selys's species *confraternus*. If such is found true, the name *confraternus* will supersede that of *sobrinus*, as the former precedes the latter in Selys's writings. The variations of the species will be dealt with more fully in the discussion of the next and closely related mountain species from Lake Donner.¹

The following are color descriptions of *sobrinus*:

Male.—Labium black in the middle; entire face and frons pale greenish yellow, except posterior edge of horizontal surface of frons, which is black as is the entire vertex; occiput yellow; eyes gray, with the posterior surface with three yellow spots. (See fig. 279.)

¹ See p. 550 of this paper concerning *sobrinus* from Seattle, Washington, collected by R. Osburn and called *confraternus*.

Prothorax black with a median and an upper and lower lateral spot yellow.



FIGS. 272-280.—*GOMPHUS SOBRINUS*. 272. MALE, SEGMENT 2. 273-275. MALE, APPENDAGES. 276-277. VULVA. 278. FEMALE, OCCIPUT. 279-280. COLOR PATTERN.

Mesothorax and metathorax dull olive green marked with dark brown as follows: Middorsal stripe 1.5 mm. wide, extending from antealar sinus to the pale posterior edge of the black mesostigmal

lamina; humeral and antehumeral stripes, 2 mm. wide, fused except for a narrow green line through the center of their middle third; upper half of mesinfraepisternum (lower half pale); a broad band connecting inferior end of humeral stripe with the broad irregular stripe on the second lateral suture (see fig. 279). Upper third of mesinfraepisternum dark but conspicuously edged above by pale. Anterior end of metepimeron black. Coxae pale, each with a black spot; legs black. Wings with large dark brown stigmas.

Abdomen black except segment 1, with dorsal and lateral greenish spots. Segments 2-9 each with a narrow triangular yellow middorsal spot, the apex caudad, and reaching posterior end of 2-6 and successively shorter on 7-9, on the last reaching but halfway. Basal articulatory membranes of segments 8-9 yellow. Segment 2 with two large pale spots on sides. Lower edge yellow. Segment 3 with a large antero-lateral spot and lower edge yellow. Segments 4-7 each with a small antero-lateral spot yellow. Segment 8 with a large yellow lateral spot reaching three-fourths distance from anterior and toward posterior end. Segment 9 with a yet larger spot greater than half the depth of the segment and tapering to a point at the lower posterior angle. Segment 10 usually entirely black but in some paler below. (Appendages, figs. 290-293.)

Among twenty selected at random, all from San Jose, five had a very small and obscure spot on 9, while in another it was reduced to a line. In one male lateral spots on 1 fuse with dorsal spot. (See figs. 299-300.)

Female.—Head and thorax colored as in male. Abdomen with more yellow.

Segment 1 greenish with a black spot above on either side. Segment 2 with a broad middorsal yellow stripe variouly pointed posteriorly, a broad lateral stripe and the lateral keel edged with yellow. Segments 3-7 similar to segment 2 but the middorsal spot more triangular. A large antero-lateral spot on each, caudad to which extends a more or less definite yellow stripe, which is interrupted or absent on 6 and 7. The lateral keel edged with yellow. Segment 8 with middorsal triangular spot one-half length of segment. Lateral spot extending four-fifths along lateral keel. Segment 9 similar to 8 but lateral spot larger, extending along keel full length of segment. Segment 10 usually black with the three caudal lobes yellow. Appendages black. Basal articulatory membranes of segments 8-10 yellow.

The female illustrated (fig. 280) is an alcoholic in perfect preservation and happened to be the most yellow of my ten specimens. The abdominal coloration in the female is exceedingly variable, no two of the ten being alike. The majority have a pattern more like the male (fig. 279) than like this female. Figures 302-305 show the

color pattern in four other females. Figures 272-278 show the structural details of this species.

Measurements are as follows: Male, abdomen, 37-40 mm.; hind wing, 31-32; female, abdomen, 36-39 mm.; hind wing, 30-32.5

Because of previous studies of the postanal cells in *Gomphus* relative to their use in grouping the species into subgenera, I give here the forms they take in this species. The fifty males were examined and 24 = A (fig. 313), 7 = B; 2 = C; 9 = D; 2 = H. Each of the other figures represented one specimen each, and one deformed wing was not figured. The females were not examined.

GOMPHUS DONNERI, new species.

One of the interesting surprises among the Odonata of beautiful Donner Lake was a species of *Gomphus*. This genus, which is associated in one's mind with the warm sluggish streams of the lowlands, was represented here at an elevation of almost 5,000 feet by numerous specimens of an almost black species, a close relative of its near lowland neighbor *Gomphus sobrinus*.

I first saw a specimen of this species on July 23, while I was collecting *Ophiogomphus morrisoni* near the outlet of the lake, but after several attempts failed to catch him. A fuller exploration of the lake revealed the sand beaches around the west end, a different shore from the cobble and pebble beaches of the east end, and on these sandy beaches of the west end, this new *Gomphus*. During two days' collecting about 80 males and 2 females were taken, and after extended search several broken exuviae were found around driftwood and boulders along the shore. Because of the very evident scarcity of females the species was probably past its prime, though still abundant. I was not fortunate enough to observe it emerging, copulating, or ovipositing. It passed most of its time resting on the bare beach or some low stone, though it occasionally lit on a low bush or weed. Along the west shore, where the sandy beach was continuous, it was the only species found, but along the west end of the north shore, where sandy stretches alternated with gravel and rock, it was associated with *Ophiogomphus morrisoni*, *Enallagma cyathigerum*, and *Argia vivida*.

Length of abdomen: Male, 37 mm. (35-38); female, 36 and 37.5. Length of hind wings: Male, 30 mm. (28-32.5); female, 31 and 32. Length of pterostigma of front wing: Male, 2.8 mm. (2.5-3.2); female, 3.

Type.—Cat. No. 20815, U.S.N.M. A male from Donner Lake, Nevada County, California, July 23, 1914.

Allotype.—Cat. No. 20815, U.S.N.M. A female from Donner Lake, Nevada County, California, July 23, 1914.

Apex of hind femur reaching to or beyond auricle, in the male, with only short spines, but in the female with about 15 long spines in the outer two-thirds of each row and 8-10 short spines in the inner third of each row. Long hairs in basal third of femur in both sexes. Anterior hamuli half as long as posterior, slightly dilated upward, then abruptly contracted to a hook which terminates the anterior edge, the tip of the hook pointing caudad. Posterior hamules leaf shaped, the posterior edge thickened, the anterior edge with a subapical point directed cephalad. (Fig. 281.) Seminal vesicle large, black, its anterior surface terminating in two broadly conical projections. Abdominal segments 8 and 9 moderately dilated, inferior edge of 9 two and a half times as long as 10. Superior appendages, when viewed from above, conical, in some specimens terminating in a poorly defined needle point. Viewed from the side, the appendages are slightly convex on the dorsal surface for the anterior two-thirds of their length and slightly concave for the posterior third. A thin ridge or lamina extends along the apical three-fourths to three-fifths on the inner, lower side of each appendage. This appears in the lateral view, but is largely hidden in the view from above. This ridge is as wide as one-third the length of the appendage, being widest in its anterior third, and tapering regularly to the apex of the appendage. Prongs of inferior appendage separated by length of inner edge of either prong; prongs diverging, frequently half the inner edge of either prong visible from above outside the superior appendages. Viewed laterally, upper and lower lines of prong subparallel and the prong terminating in a short tooth pointing dorsad. Viewed from above, the outer line convex in basal two-thirds and straight or slightly concave in distal third; tip rounded. (Figs. 282-285, 294-298.)

Vulvar lamina of female broadly V-cleft, the lobes as long as wide, with blunt points. Female appendages as long as 10. (See fig. 286.)

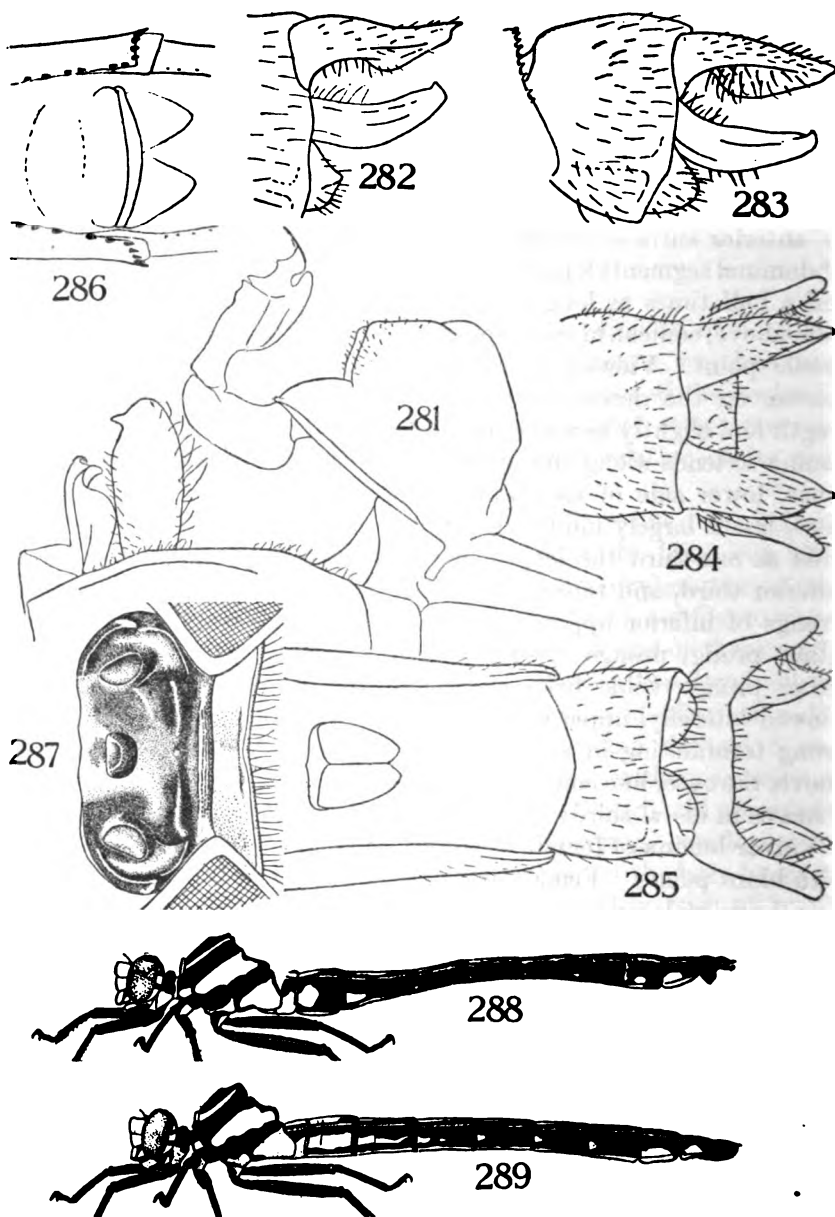
In both male and female the under surface of the occiput is not visible from above; that is, the posterior edge does not turn up as in *Stylurus*. This edge in the two females is straight; in the majority of the males a slightly convex curve, lightly indented in the center. (Fig. 287.)

Coloration, male.—Labium black with yellow lateral edges; entire face and frons greenish yellow except posterior edge of horizontal surface of frons, which is black, as is the entire vertex; occiput yellow. Eyes gray with three yellow spots behind each. (See fig. 288.)

Prothorax entirely black, except obscure median dorsal spot, and in some specimens minute upper and lower lateral spots.

Mesothorax and metathorax dull grayish olive green, marked with black as follows: Middorsal stripe 1.75 mm. wide, extending from the black antealear sinus to the pale posterior edge of the black mesostigmal lamina; humeral and antehumeral stripes entirely fused into a stripe 2.5 mm. wide; a broad band connecting inferior end of

humeral stripe with lower end of the broad stripe on the second lateral suture; anterior and ventral edge of metepimeron broadly



FIGS. 281-289.—*GOMPHUS DONNERI*. 281. MALE, SEGMENT 2. 282-285. MALE, APPENDAGES. 286. VULVA. 287. FEMALE, OCCIPUT. 288-289. COLOR PATTERN.

black. Mesinfraepisternum and metinfraepisternum black above, yellow below. All coxae yellow, each with a black anterior spot. Legs black. Pterostigmas very dark, almost black.

Abdomen black, except a broad middorsal band on segments 1 and 2; lower side of 1 green, which is confluent with a large green spot on side of 2 (in some specimens a second and minute spot posterior to auricle). Lateral keel of segments 1-3 yellow. Segments 3-7 each with a narrow middorsal triangular yellow spot extending full length of segments 3 and 4, and successively shorter to the eighth on which it occupies only the anterior fourth. Large anterolateral spot on segment 3, the anterolateral spots on 4-7 being reduced to mere points. Basal articulatory membranes of segments 8-10 yellow, all others black. A large yellow spot, three-fifths the length of the segment, occupying the lower anterior angle of segment 8. A similar but larger spot occupying the anterior two-thirds of segment 9 and extending caudad along the keel but not reaching the posterior end of the segment as in *sobrinus*. Segment 10 and appendages black.

Female.—Color similar to that of male except on abdomen, which is colored as follows (fig. 289): Black with more extensive yellow pattern than in the male. Segment 1 black, with large dorsal spot and sides yellow. Segment 2 black, with large oval dorsal spot full length of segment and broad lateral stripe with a second narrow stripe along lower edge yellow. Segments 3-7 each with a narrow triangular middorsal spot extending full length of segment; each with lateral keel narrowly yellow. Segment 3 with an irregular lateral stripe. Segment 4 with an anterior lateral spot followed by a second and smaller spot. Segments 5-7 each with an anterior lateral spot larger than those in the male. Segment 8 with short triangular middorsal spot on anterior end of segment, and a large lateral spot extending along three-fourths of the length of lateral keel and dorsad half the height of the segment. Segments 9 and 10 black, except a large lateral yellow spot on 9 extending along the entire length of the lateral keel and at its anterior end dorsad half the height of the segment. The three round terminal lobes of segment 10 yellow. Articulatory membranes of segments 8-10 yellow.

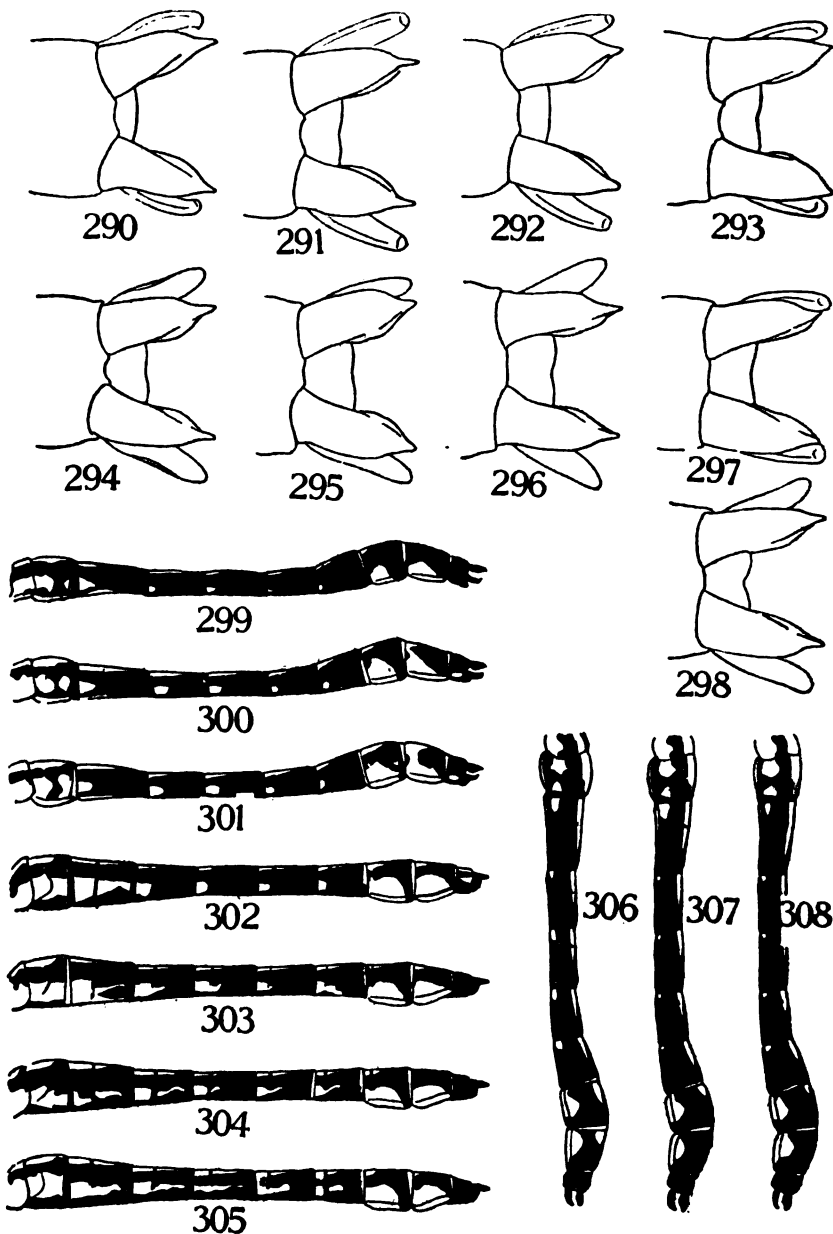
The variations of the cells between A and A₂, on being checked against figure 313, show 8 = A, 10 = B, 11 = C, 15 = D, 10 = F.

Donneri is very close to *confraternus*, appearing to differ only in coloration. *Confraternus*, which I have not seen, has blunt superiors but has a double humeral stripe. *Donneri* and *confraternus* both are smaller than *sobrinus* and both have little or no color on the dorsum of segment 9.

In the collection of Cornell University are three males and one female from Seattle, Washington, collected by R. Osburn,¹ which are labeled *confraternus*. These agree with my *sobrinus* specimens from California in detail, having the larger size of *sobrinus*, the double humeral stripe, the large spot on the dorsum of segment 9, the lateral spot on 9 reaching to the lateral inferior angle of the seg-

¹ Osburn, R., Ent. News, vol. 16, 1905, p. 189.

ment and the pointed superior appendages. The exuviae from Seattle, described by Dr. J. G. Needham¹ as *sobrinus*, are a form near *olivaceus*,



FIGS. 290-293, 299-305.—*GOMPHUS SOBRINUS*. 290-293. MALE, APPENDAGES. 299-305. COLOR VARIATION. FIGS. 294-296, 306-308.—*GOMPHUS DONNERI*. 294-296. MALE, APPENDAGES. 306-308. COLOR VARIATION.

which has been reported from Peachland, British Columbia.² The nymphs from Crooked River (Baker County), Oregon, described by

¹ Proc. U. S. Nat. Mus., vol. 27, 1904, p. 692.

² 41st Report Ent. Soc. Ont., 1909, p. 120. (E. M. Walker.)

Doctor Needham¹ as *confraternus*, are close to the nymphs of *donneri* but are slightly broader.

In color this species is characterized and set off from *sobrinus* by the narrow antehumeral stripes (1 mm.), the solid black humeral stripe, the minute lateral spots on segments 4-7, the usual absence of a dorsal spot on segment 9, and the fact that the lateral spot of segment 9 never quite reaches the lower posterior angle of the segment. (See figs. 306-308.)

Structurally the species is characterized by its shorter pterostigma (2.5-3.2 mm.), by its more slender abdomen and by its more blunt superior appendages and slightly lyrate inferior appendage.

This species is very close to *sobrinus*, differing from it in the above characters and in its season. The season of *sobrinus* is entirely past before this reaches its prime. The difference in altitude would account for part of this, but hardly for so great a difference. And as to the characters above, none of them are constant except that of the extent of the yellow lateral spot of segment 9. In *sobrinus* it always attains the posterior angle and in *donneri* it never does. Occasional specimens show intergradations in any of the other characters, but no single specimen from the valley (*sobrinus*) or from the lake (*donneri*) shows a major part of its characters varying toward the other species.

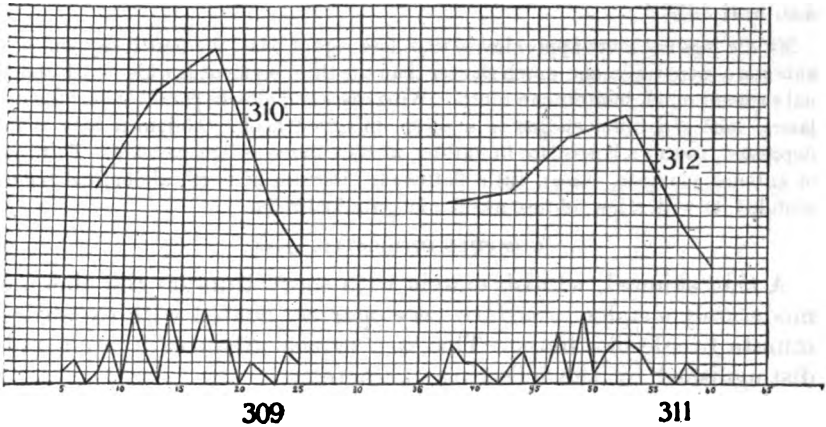
To test this I tabulated each specimen of the males of the two species (54 *donneri* and 50 *sobrinus*) in regard to the following seven characters: 1, width of pale antehumeral stripe; 2, length of pale mid-humeral stripe; 3, length of stigma of left forewing; 4, extent of lateral spot of segment 9 along the inferior edge of the segment; 5, length of dorsal spot on segment 9; 6, character of superior appendages (whether needle pointed *sobrinus* form or the blunt *donneri* form or one of three intermediate forms); 7, character of inferior appendage. The table (see p. 568, table A) following shows the variations and the number of specimens showing any given variation. The arrangement of the table brings out the overlapping or intergrading of the various characters.

To show the distinctness of the two groups of dragonflies in spite of the intergrading of the various characters, I reduced the measure of each character to its equivalent in a scale of ten, allowing 0 for the extreme *donneri* form of each character and 10 for the extreme *sobrinus* form of each character. The equivalents for each character are inserted in the table of variations.

Following this (see p. 568, table B) are for example the measurements of the first three *donneri* specimens and following each in the table are inserted the equivalents for that specimen with their sum in the end column.

¹ Proc. U. S. Nat. Mus., vol. 27, 1904, p. 601.

The sum of the equivalentents, then, gives the variational standing of the individual. That is, a *sobrinus* with each character of extreme *sobrinus* form would total 70 and a *donneri* with each character 0,



FIGS. 309-310.—*GOMPHUS DONNERI*. 309. CURVE REPRESENTING ABOUT 50 SPECIMENS. 310. SAME CURVE AS 309 REDUCED TO PERIODS OF 10.
FIGS. 311-312.—*GOMPHUS SOBRINUS*. 311. CURVE REPRESENTING ABOUT 50 SPECIMENS. 312. SAME CURVE AS 311 REDUCED TO PERIODS OF 10.

or the extreme *donneri* form, would total 0 and a perfect intermediate would total 35. Figures 309 and 311 are curves representing the two species and figures 310 and 312 are these same curves redrawn

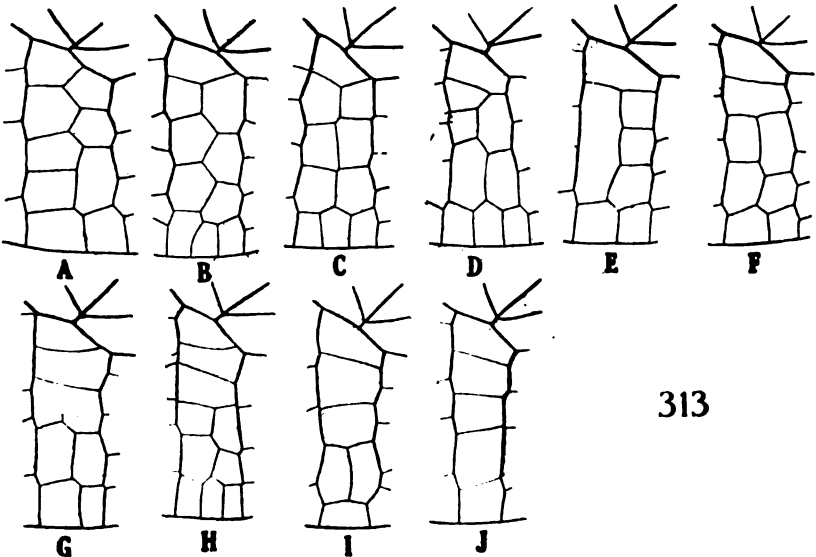


FIG. 313.—*GOMPHUS SOBRINUS*, VARIATIONS IN THE ANAL AREA IN THE MALE HIND WINGS.

to groups of 10 to smooth them up. These curves show better than words the distinctness of the two species.

I am not familiar enough with the genus *Gomphus* to attempt to place these species in a subgenus.

13. THE NYMPHS OF WESTERN GOMPHUS.

The following characterization of the nymphs of *Gomphus* is from Doctor Needham's *Aquatic Insects in the Adirondacks* (pp. 435-436 and 443):¹

Middle legs not more approximate than fore legs at base, the fourth segment of the antenna a mere rudiment, much shorter than the third segment is wide; tenth abdominal segment much shorter than ninth. Wing cases laid closely parallel along the back; lateral lobe of labium ending in a sharp, incurved hook. Abdomen only slightly depressed, ovate to lanceolate in outline, at least twice as long as wide. Third joint of antenna elongate, linear, little flattened. Dorsum of ninth abdominal segment rounded, or with a low, obtuse median longitudinal ridge.

GOMPHUS INTRICATUS, nymph.

A thin skinned, whitish exuvia with sooty tints on the abdomen; moderately slender. Surface very sparsely coated with exceedingly minute bristle-like hairs. This is a typical *Stylurus* nymph and is distinguished by the following characters:

Mentum of labium transparent, tapering proximad with sinuate sides, width of posterior margin one and three-fourths times in that of anterior margin. Middle lobe convex, with a fringe of about 60 bristlelike scales. Each lateral lobe broad at base, with a crescentic tip that is suddenly contracted to a large terminal point standing at right angles to the lobe; three large and two smaller rounded teeth on the concave edge posterior to the terminal point. Burrowing hooks rudimentary on both first and second tibiae. Wing pads reaching to segment 4. Abdomen lanceolate, very slightly contracted at base of segment 9, subcircular in cross section. A dorsal groove on segments 3-7. No middorsal hooks or spines. Segments 6-9 with lateral hooks, those on 9 one-half the length of segment 10. Segments 2-9 subequal in length; segment 10 one-third the length of segment 9, and twice as wide as long. Appendages twice length of 10. (See figs. 315 and 321-323.)

Length, 27 mm.; abdomen (including appendages), 19; hind femur, 4. Width of head, 5 mm.; abdomen, 6.

Described from 4 female nymphs collected on the Humboldt River at Lovelocks, Nevada, August 10, 1914. These were taken from dead weed stems 2 feet above the lowest level of the river. At this point was a deep hole (3 feet) with a muddy bottom, the greatest part of the river bed being composed of a coarse grit.

GOMPHUS OLIVACEUS NEVADENSIS,² nymph.

A large, slender, whitish exuvia, sparsely covered with minute bristlelike hairs. This is a typical *Stylurus* nymph and is distinguished by the following characters:

¹ Bull. 47, N. Y. State Mus., 1901.

² A form of *olivaceus* nymph has been described by Needham from Seattle, Washington, as *sebrinus* in Proc. U. S. Nat. Mus., vol. 27, 1904, p. 892.

During August, 1915, I found the same form of *olivaceus* on the Owens River, Inyo County, California, as that found at Sacramento, which is the typical *olivaceus*. The nymphs of the Owens River *olivaceus* were identical with those of *Gomphus olivaceus nevadensis*.

Mentum translucent, its width one and two-fifths in its length; sides of anterior portion subparallel and quickly contracted by a short sinu-

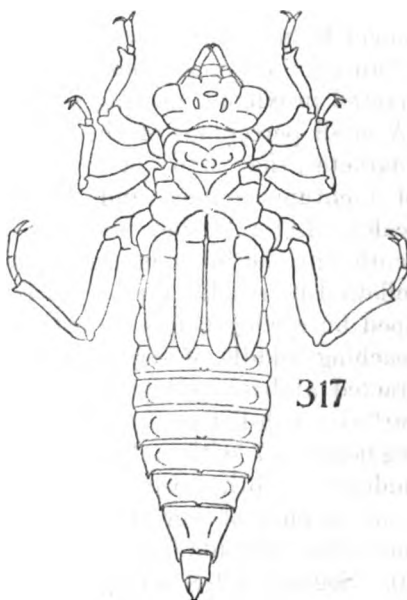
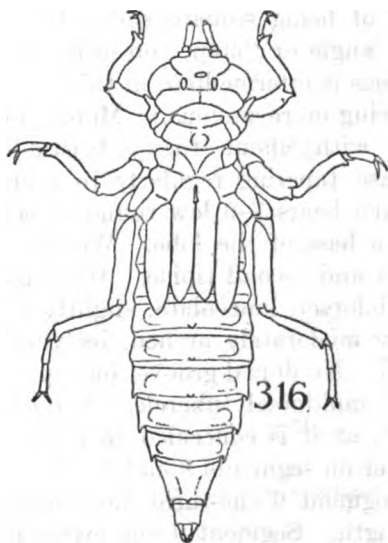
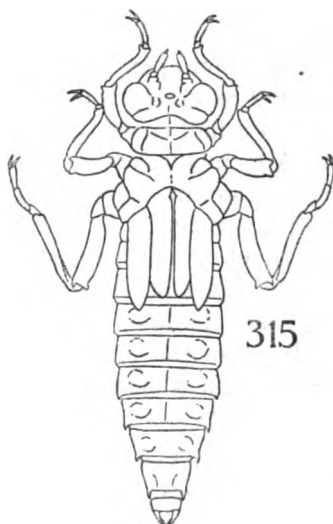
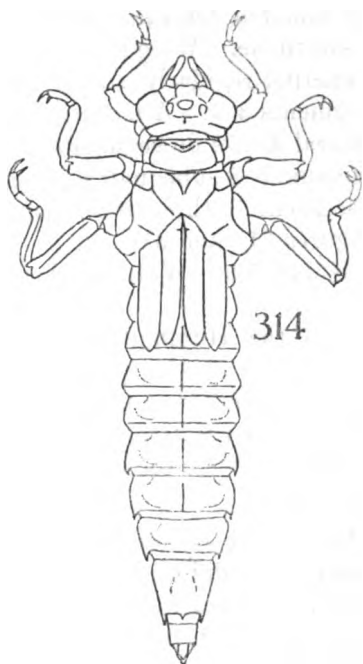


FIG. 314.—*GOMPHUS OLIVACEUS NEVADENSIS*, NYMPH.
FIG. 315.—*GOMPHUS INTRICATUS*, NYMPH.

FIG. 316.—*GOMPHUS DOWNERI*, NYMPH.
FIG. 317.—*GOMPHUS SOBRINUS*, NYMPH.

ate curve to the narrower posterior portion, which tapers slightly; width of posterior end one and a half to one and three-fourths times

in that of anterior end; middle lobe convex, with 30-35 bristlelike scales; each lateral lobe with a crescentic tip turned inward at right angles; on the concave edge 3-4 large rounded teeth. Burrowing hooks rudimentary on both first and second tibiae. Wing pads reaching segment 4. Abdomen lanceolate, tapering regularly, subcircular in cross section. A dorsal groove on segments 3-7. A minute mid-dorsal spine on apex of segment 9. Lateral hooks on segments 6-9, those on 9 reaching to base of 10. Segments 3-8 subequal; segment 9 one and a half times the length of 8; segment 10 three-fifths length of 8. Appendages equal to 10. (See figures 314 and 318-320.)

Length, 38 mm.; abdomen, 26; hind femur, 5.5. Width of head, 6 mm.; abdomen, 7.

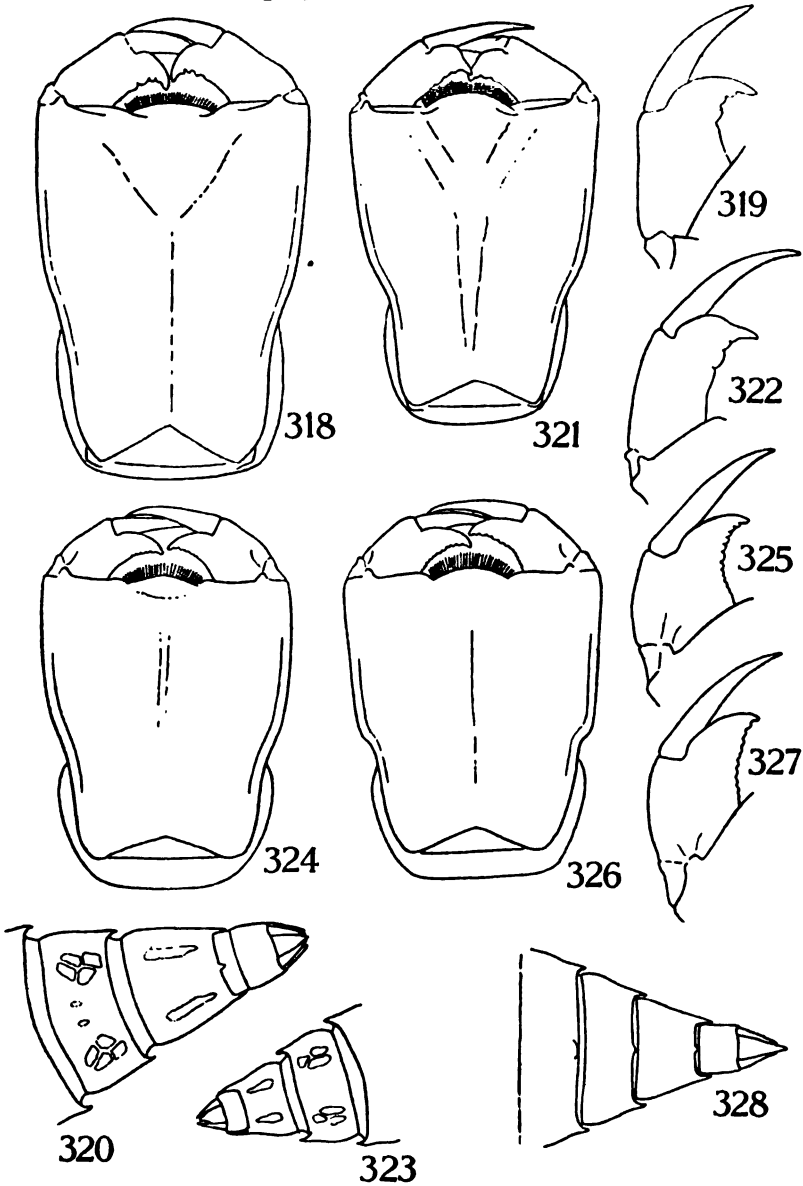
Described from 6 exuviae collected on the Humbolt River at Golconda, Nevada, August 9, 1914. The river at this point flows through an alkaline, salt-grass flat. As it meanders it undermines the salt grass sod which caves into the edge of the stream in large squares. It was on these sods that the exuviae were found.

GOMPHUS SOBRINUS, nymph.

A heavy thick-skinned exuvia usually thickly coated with mud because of a dense coat of very short spiny hairs, differing noticeably in this regard from *donneri* exuviae, which have few hairs and these usually very clean. General shape intermediate, neither short nor slender. Abdomen much less arched than in *donneri*. It is distinguished by the following characters: Mentum of labium slightly longer than wide, its posterior edge three-fifths to two-thirds width of anterior edge, its sides instead of being sinuate suddenly contracted proximad, making a sharp angle or "step" on either side. (A small percentage of the specimens is intermediate in this mental character, the "step" of the side being more sinuous.) Middle lobe of mentum convex and fringed with about thirty bristle-like scales. Lateral lobes broad at base, tapering regularly to a crescentic tip, the inner margin of which bears 7-9 low rounded teeth, followed by smaller ones toward the base of the lobe. Well developed burrowing hooks on both first and second tibiae. Wing pads reaching middle of segment 4. Abdomen lanceolate, slightly contracted at base of segment 9, only moderately arched, its ventral surface much flatter than in *donneri*. No dorsal groove, but apex of segments 2-7 with a low rounded middorsal tubercle. A minute middorsal tooth, hardly discernible, as it is concealed in a tuft of hairs on apex of segments 2-7, larger on segments 8 and 9. Lateral hooks on segments 6-9, those on segment 9 one-third the length of 10. Segments 2-8 subequal in length. Segment 9 one and a half times the length of 8; segment 10 two-thirds the length of 8. Appendages equal to 10. (See figs. 317 and 326-328.)

Length, 38 mm.; abdomen, 26; hind femur, 5.5. Width of head, 6 mm.; abdomen, 7.

This species differs from *donneri* in the sides of the mentum being angulated, in the heavier skinned character of the exuvia and in the dense coat of minute, spiny hairs.



FIGS. 318-320.—*GOMPHUS OLIVACEUS NEVADENSIS*, NYMPH. 318. MENTUM. 319. MENTAL LOBE. 320. SEGMENTS 8-10.
 FIGS. 321-323.—*GOMPHUS INTRICATUS*.
 FIGS. 324-325.—*GOMPHUS DONNERI*.
 FIGS. 326-328.—*GOMPHUS SOBRINUS*.

Described from exuviae collected May 31, 1914, on Coyote Creek, San Jose, California, where the exuviae were numerous along the mud banks of the stream.

GOMPHUS DONNERI, nymph.

A light colored, very delicate and thin skinned exuvia, its surface thinly covered with very short, spiny hairs. General shape intermediate, neither broad nor slender. It is distinguished from other *Gomphus* nymphs by the following characters:

Mentum of labium slightly longer than wide, its posterior edge two-thirds width of anterior edge, its sides slightly sinuate. Its middle lobe convex, with a fringe of about 30 bristlelike scales. Lateral lobes broad at base, tapering regularly to a crescentic tip, the inner margin of which bears about 7 low rounded teeth between which and the base of the lobe are other smaller teeth. Well developed burrowing hooks on both the first and second tibiae. Wing pads reaching to or beyond apex of third segment. Abdomen lanceolate, slightly contracted at base of ninth segment, well arched, no sign of a dorsal groove, but apex of segments 2-7 with a low rounded middorsal tubercle terminating caudad in a minute middorsal tooth on apex of segments 2-7, larger on segments 8 and 9. Lateral hooks on segments 6-9, those on 9 one-fourth to one-third the length of segment 10. Segments 2-8 subequal in length; segment 9 one and a half times as long as 8; segment 10 as long as broad and two-thirds length of 8. Appendages as long as segment 10. (See figs. 316 and 324-325.)

Length, 29 mm.; abdomen, 20; hind femur, 6. Width of head, 5 mm.; abdomen, 6.5.

Described from 2 male and 1 female exuvia and 6 fragmentary exuviae collected on the west end of Donner Lake, California, July 24, 1914. These were found in the trash of the wave line on the sandy beaches along the northwest point of the lake.

14. NOTES ON OCTOGOMPHUS SPECULARIS AND ITS NYMPH.

This graceful dragonfly appears most commonly and in greatest abundance on the perennial torrents of the coast mountains of California. These are streams which never freeze, not even carrying snow water, and which vary in size from trickling spring streams to roaring torrents. The coast mountains are heavily timbered with redwoods and fir on their ocean slopes, but on their eastern side are covered with dense growths of brush except in the deep V-shaped gulches where are found mixtures of redwoods, oaks, alders, and bays. It is in the rushing streams which hurry down through the dense shade of these steep and narrow gorges that *Octogomphus* is found. Here it is accompanied by only three other dragonflies. *Cordulegaster dorsalis* and *Aeshna walkeri* breed with it in the stream and *Argia vivida* occupies the springs along the lower courses of the torrents. Both *Octogomphus* and *Cordulegaster* are confined to the torrential headwaters of the stream but *Aeshna walkeri* and *Argia*

vivida may occur along the stream for some distance after it emerges onto the more level valley floor. Besides occurring on all the streams of the Coast Mountains, *Octogomphus* is found on the smaller streams of the west slope of the Sierras which are perennial but do not rise high enough in the mountains to carry snow water.

From April to August it is abundant on the mountain streams west of Stanford University. On June 8 I found it common on the small streams in the gorge east of the Napa Asylum. This record for Napa County, California, is at present the northernmost record for the Coast Mountains, though it will probably be found as far north as southwestern Oregon, when that region is explored. On June 15 I found numerous exuviae along the banks of the Chico River, where it emerges from the gorge east of the city of Chico. This point, in Butte County, California, is on the west slope of the Sierras and is at present the northernmost record for the species. My southernmost records are from Mr. Fordyce Grinnell's collection in the Southwest Museum of Los Angeles, one being a specimen from the San Gabriel Mountains and the other from the Mount Wilson trail, both in Los Angeles County.¹ Calvert² records this species from Baja or Lower California.

For a gomphine this species has a very long season, probably the longest season of any of the western gomphines. A teneral male was taken on San Francisquito Creek (Santa Clara County, California) April 20, 1914. Many were seen on Stevens Creek (Santa Clara County, California) May 31, while oviposition was observed on the same stream on July 17 and two old males were captured there on August 16, which is the latest seasonal record for the species.

The nymphs of this species occur abundantly in the leafy trash which collects in the pools and eddies of the stream. I do not believe that they burrow in the sandy bottom, as I have observed no tracks even where the exuviae showed the species to be very abundant. In June, after the annual emergence, I found two sizes of nymphs, the larger of which was immature and would have emerged the following season (1915). (See figs. 342-344.) The nymphs included in the smaller size showed considerable variation in size, but as there was a complete series between the largest and the smallest, I concluded that they were probably from early and late ovipositings of the same year and all would emerge in the second season (1916) (see figs. 342 and 343). This would indicate that the nymphs spend three years in the water. Nymphs taken August 16 had assumed the final stage, in which they wintered to emerge the following season. The emergence takes place previous to May 31, probably occurring (on Stevens Creek, Santa Clara County) during the latter half of

¹ In August, 1915, I found *Octogomphus* nymphs in the headwaters of the Mojave River. Since writing the foregoing I have found in Dr. P. P. Calvert's collection an *Octogomphus* female collected by Prof. Trevor Kincaid, July 26, 1895, at Olympia, Washington.

² Proc. Cal. Acad. Sci., ser. 2, vol. 4, 1895, p. 502.

April and the first two weeks of May, for on May 31 I found the exuviae very abundant and no mature nymphs were found. The exuviae were found about the roots of the alder trees, especially where these overhung pools, and usually occurred from one to two feet above the water. On Zyante Creek, a tributary of the San Lorenzo near Santa Cruz, California, frequently a dozen exuviae were found on one tree root.

After emergence the imagoes appear to migrate upstream, not a migration in numbers but each individual probably gradually working up to the swifter waters. This same upstream migration is observable in the associated species, *Cordulegaster dorsalis*. My observations are as follows: On Stevens Creek, where, because of its nearness, I have been able to observe *Octogomphus* at various seasons, exuviae were very abundant in the 2 miles from the trout farm up to the soda spring but occurred less commonly above this point. Imagoes were not found below the soda spring in this region of greatest emergence, though they were common above the spring, even to the head of the creek on the divide 8 miles distant. On the lower stretch of Zyante Creek on July 9, the exuviae were very abundant but not a single imago was observed. The same was true for the Chico River where it emerged from the canyon east of the city of Chico (Butte County, California).

As the nymphs apparently do not burrow in the bed of the stream but live in the loose organic trash that collects in the pools and eddies, this upstream migration is probably to offset the washing down of the nymphs during the winter rainy season when the streams are foaming mill races. Theoretically, some such compensation should occur or this species would gradually spread to the lower portions of these streams, where it is certainly not now found.

As with most gomphines, the males of this species stay near the water while the females are seldom seen there. The males are usually found in the sunlit openings of the streams where they perch on stones, driftwood, or on the foliage of the surrounding alders. But while preferring the sunny spots they do not hesitate to hunt up and down stream through the shade. The four females I have taken were found along a road on the side of the gorge several hundred feet above the stream. They appear to resort to the stream only to oviposit.

After having spent various days wading down mountain streams observing *Octogomphus* more often than catching them, I was rewarded on July 7 by seeing a female oviposit. She came volplaning down through an opening in the canopy of alders and, while going through evolutions involving several figures, 8's and S's, she touched the surface of the pool lightly with the tip of her abdomen at intervals of 2 to 6 feet. After 20 seconds of this she airily spiraled up and out into the sunshine, where she alighted on a bush on the hillside above the creek.

The following are live color notes of *Octogomphus*:

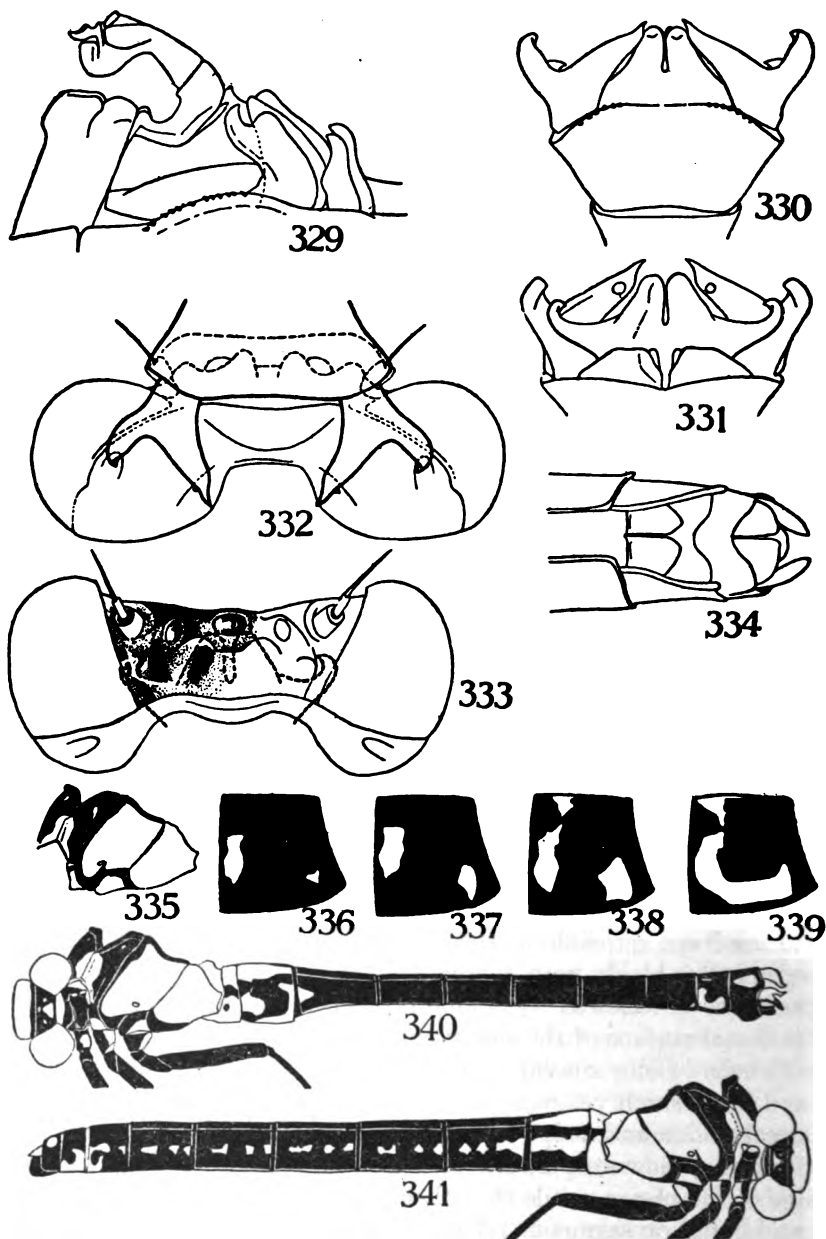
Male.—Labrum black, its lateral edges yellow. Face greenish yellow, with the labrum edged with black above and below, and a triangular spot on its median line; nasus black, in some specimens pale but surrounded by black. Vertex and occiput black, except triangle of greenish yellow posterior to the ocelli. Rear of head black. Eyes gray. (See figs. 336–340.)

Prothorax with anterior lobe yellow and a broad middorsal stripe yellow, otherwise black. Mesothorax and metathorax greenish yellow with a very broad black antehumeral stripe which, in some specimens, extends caudad slightly beyond the humeral suture. In some individuals the humeral stripe is divided by a vertical yellow line, a remnant of which always remains as a small, round, yellow spot in the upper end of the black stripe (see figs. 335 and 340–341). Antear and lateral alar ridges black. Second lateral suture narrowly black, and side of thorax edged with black below. Both infraepisterna greenish, bordered with black above. Coxae greenish, heavily marked with black. Legs black. Pterostigmas black.

Abdomen black, with a broad greenish-yellow middorsal stripe on segments 1 and 2, which is attenuated caudad in a fine hair line on segments 3 to 6. Side of segment 1 greenish, in the center of which is a small black spot. Auricle on segment 2 greenish yellow, which color also forms a wide stripe along the posterior and ventral edges of its side. Segment 3 with an anterolateral spot and its lower edge yellow. The intersegmental membrane of segments 7–10 yellow. Segment 9, black, except a minute middorsal spot and yellow mottling on its side, which is usually confined to an anterior and a posterior spot, but in some specimens a bar joining these. The figures 336–339 show the variation in this mottling. Perhaps extensive series might show local races with regard to these mottlings, as the Stevens Creek specimens have the least yellow on segment 9 and the Napa series shows several with the spots large and confluent. Segment 10 black, with a large oval middorsal spot, which in most specimens is followed by a minute spot. Appendages black, except the dorsal surface of the superiors, which is yellow.

Female.—Color similar to that of the male. Each of the two at hand has a small yellow spot in the dorsal end of the humeral stripe. Dorsal abdominal stripe as in the male. The side of the abdomen with two yellow stripes, one of which is a hair line along the lower edge of the pleura, while the other is a midlateral stripe on segments 1 and 2, but on segments 3–7 breaks up into a series of small yellow dots, of which there are two to four on each segment. Segments 8 and 9 with yellow mottling on the side. Segment 10 black, except a round middorsal spot. The superior appendages and the cerci yellow. (See figs. 335 and 341.)

In the male, and probably in the female, the teneral colors are bright yellow and black. This teneral yellow changes to greenish



FIGS. 329-341.—*OCTOGOMPHUS SPECULARIS*. 329. SEGMENT 2 OF MALE. 330-331. MALE, APPENDAGES. 332-333. MALE, APPENDAGES AS APPLIED TO HEAD OF FEMALE. 334. FEMALE, SEGMENTS 9-10. 335. THORACIC COLOR IN A PASADENA, CAL., FEMALE. 336-339. VARIATION IN COLOR OF SEGMENT 9 IN MALE. 340-341. COLOR PATTERN.

yellow in breeding individuals, and in very old ones fades to a pale gray with scarcely a trace of the green remaining.

This species is peculiar to Lower California and the coast of California. In spite of its peculiarities in color and structure its venation shows it to be a near relative of the cosmopolitan genus *Gomphus*.

The figures show the structural oddities of this species. In the male the superior appendages are bifurcate, the two outer hooks fitting into narrow recesses on the dorsal edge of the postocular surfaces of the female, while the spines on the inner rami fit into special depressions lower down on the postocular surfaces. The four prongs of the inferior appendage hook over the four tubercles on the vertex of the female. (See figs. 330-333.) The coloration is unusual in gomphines in that the middorsal thoracic stripe is yellow instead of being dark. Figure 329 shows the male genitalia on segment 2, and figure 324, the female genitalia.

Measurements of 10 males and 2 females are as follows: Length of abdomen: Male, 36-39 mm.; average, 37.3; female, 35 and 38 mm. Length of hind wing: Male, 29-31 mm.; average, 30.1; female, 30-32 mm.

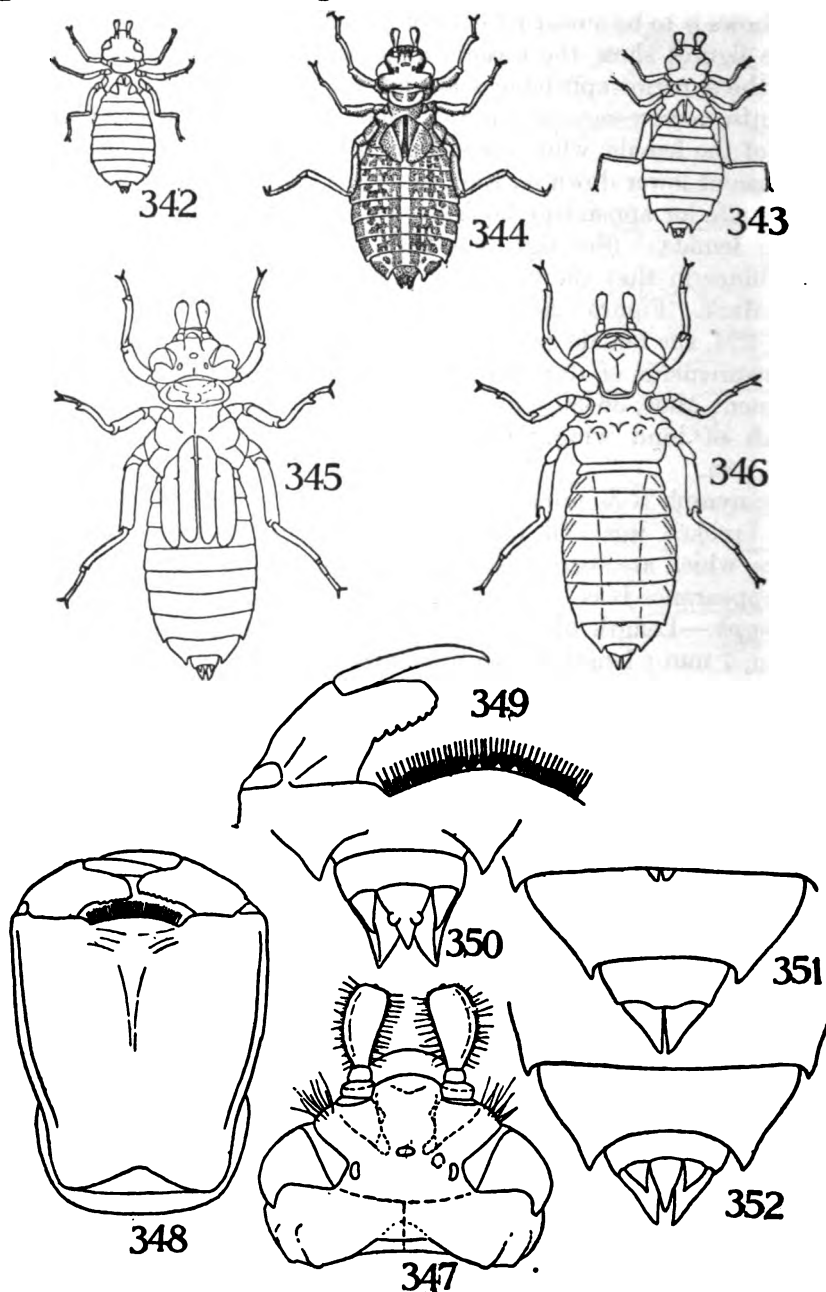
The nymph is as interesting as the imago, as it does not show the short crooked legs and other features characteristic of most gomphines, which are correlated with their burrowing habits. In habits and appearance it is more corduline than gomphine.

Nymph.—Length of exuvia, 24 mm.; abdomen, 15; width of abdomen, 7 mm.; length of hind femur, 5 mm.

Body flat, deeper and more cylindrical in the exuvia than in the live nymph. (See figs. 342-352.)

Head broad cordate, flat above, conspicuously granulated over entire surface. Occiput slightly concave, postocular angles rounded and postocular areas each entirely covered by a large scar which is characterized by from two to four vertical ridges. Antennae: Two basal joints globular, second smaller than the first, third joint three times as long as combined length of first two and one and a half times as wide, depressed, elongate-obovate when viewed from above, its inner edge less convex than its outer; fourth segment a mere tubercle set in the end of segment 3. Head naked except for long hairs on genae and a series of mixed long and short hairs on the edges of the third antennal segment, and numerous short hairs on the labrum. Labium reaching to the posterior side of the fore coxae. Anterior segment of mentum only slightly less broad than long, its posterior end two-thirds as wide as the anterior end. Median lobe regularly convex; its edge with from 30 to 40 long bristles among the bases of which are numerous shorter bristles; four large conical teeth on its middle third, these placed just below or outside the double row of bristles. Lateral lobe short and broad, its end squarely truncate but no inner apical hook, the outer three-fifths of its inner edge with

six to eight broad blunt teeth, these directed proximad and the series graduated distad. (See figs. 348-349.)



FIGS. 342-352.—*OCTOGOMPHUS SPECULARIS*, NYMPH. 342-346. NYMPHS. 347. HEAD. 348. MENTUM. 349. MENTAL DETAIL. 350. MALE, APPENDAGES. 351-352. FEMALE, APPENDAGES.

Dorsal surface of prothorax with an elevated semicircular flat area in the center of which are twin tubercles. No supracoxal processes,

but long hair just above the coxa. Wing pads parallel and reaching almost to the fifth abdominal segment. Legs short but not especially distorted for burrowing; burrowing hooks on fore and middle tibiae.

Abdomen flat ventrally, convex dorsally and thin at the edges, ovate when viewed from above. This may be broadly ovate in the live nymph, which can make itself very flat (thin dorso-ventrally) or narrowly ovate in the exuvia, which is convex on both dorsal and ventral surfaces. Short lateral spines on segments 7, 8, and 9. Segment 10 one-half as long as segment 9 and slightly more than one-third as wide, but one-third longer than the lateral spines of segment 9 between which it lies. Appendages of segment 10 short, conical, the inferiors twice as long as segment 10, the middle only slightly less long, the dorsal paired appendages slightly longer than 10. The entire thorax and abdomen granulated except the intersegmental membranes. Postero-dorsal and lateral edges of segments 2-8 with a crowded row of short heavy bristles scattered among which are very long hairs. Segment 1 is one-third as long as segment 2. An impressed line on each side of the median line of the ventral surface, each line running out posteriorly at the base of the lateral spine on segment 9.

The male larvae can be told by the scar on segment 2, the females by the genitalia at the base of segment 9.

Octogomphus imagoes are close to *Gomphus* in the venation of the wings and the nymphs are very similar to those of *Lanthus*. They differ from nymphs of *Lanthus albistylus*¹ in greater size, in the narrower third joint of the antennae, in the narrower head, in having two to four vertical ridges on the postocular areas instead of one large one, in the smaller teeth on the lateral lobe of the labium and that these are larger at the proximal end of the series. (Both have four teeth on the middle lobe.) Legs and thorax and abdomen are similar except that there are lateral hooks on segments 7-9 in *Octogomphus*, while in *Lanthus* they occur only on segments 8 and 9.

15. NOTES ON AESHNA INTERRUPTA NEVADENSIS AND ITS NYMPH.

This dragonfly, originally named *nevadensis* by Dr. E. M. Walker, is classed in his recent monograph as a variety of *Aeshna interrupta*. Only eight specimens, all males, are recorded. These were collected at Reno, Nevada, by H. K. Morrison, and were deposited in the Museum of Comparative Zoology.

This *Aeshna* is an alpine form. I first met it on July 21, when I was climbing down the thousand-foot hill from Emigrant Gap (California) into Bear Valley. Here, on the fir-covered hillside along the power company's canal, two specimens were catching insects with that peculiarly airy flight and dextrous turning characteristic of this variety. I was unable to catch either, and decided they were *Aeshna interrupta interna*, which they resembled in appearance and habits.

¹ Collected by E. B. Williamson on Pine Creek, Ashland County, Ohio, June 7, 1915.

During the day, I took *Aeshna multicolor* about the lake in the floor of the valley, and *Aeshna palmata* among the willow thickets. On returning at 4 o'clock in the afternoon, I found a single *Aeshna* catching Diptera in an open glade of the hillside, where, with numerous short turns up and down and sidewise, and an occasional figure eight, and various volplanings, it was exhibiting the same ease on the wing as shown by a *Brechmorhoga*. On catching it I saw it was a *nevadensis* teneral. Bear Valley lies at an altitude of 4,500 feet, the lowest altitude at which I took this species.

I next met this species at Donner Lake, California, at an elevation of 5,200 feet, where it was associated with *Aeshna palmata* and an occasional *Anax junius*. Here on cool windy days it hunted among the willow thickets, but on bright, warm days it spent most of its time hunting high and wide, much after the habit of *multicolor*, seldom coming lower than 10 or 15 feet above the ground. But even on the cool days, when flying frequently in the protection of the willow clumps, it never persisted in confining itself to a low, thoroughly protected beat as does *umbrosa* or *palmata*, both of which will work many minutes at a time on a short beat only 4 to 6 feet above the ground. On July 25, in Donner Creek, 200 feet from the outlet of the lake, I took several exuviae clinging to a log, and one nymph, which was ready to emerge.

Along Truckee River, California, for the 9 miles from Squaw Creek to Lake Tahoe, and along the west shore of Lake Tahoe, *nevadensis* was common, frequently three or four being in sight at the same time. Observations here indicated that their flight was free and wide, the individual making from one to a half dozen wide turns in an open space, and then wandering on into the next glade, with an occasional few minutes hanging from some limb usually high in the air.

I next met this species at an elevation of 6,500 feet in a small meadow-like opening of the fir forest, where the Rubicon Springs road crosses McKinney Creek (California). Here at 9 o'clock in the morning it was cool and in an hour I had caught five or six on the wing. They were flying low and many stopped flight to hang on weeds only a foot or two high. Such a one would hunt for a suitable weed, and after trying one or two, would hang from the underside of one of the leaves, when it was easily taken by approaching from the opposite side, and slapping the net over both weed and dragonfly. Also I saw several flying close over the surface of the creek on short beats, apparently after small insects which hovered over the surface of the water. No other species of *Aeshna* was seen or taken here or elsewhere around Lake Tahoe, with the possible exception of a single exuvia from the McKinney Lakes which Doctor Walker referred to *palmata*.

I finally found this species in its greatest numbers about four lakes on the divide between McKinney Creek and the Rubicon River

(California), where, at an elevation of 7,000 feet, this species dominated all other dragonfly life. Here, in a mountain pass fairly level for about two miles, lie four small, shallow lakes, two of which flow east into McKinney Creek and Lake Tahoe, and two flow west into the Rubicon River and the Pacific drainage. On both sides rise granite crags for a thousand feet above the level of the lakes, with their lower slopes and the borders of the lakes covered by green firs, and their higher naked slopes spotted white with small patches of snow. Three of the lakes are covered with yellow pond lilies and fringed with sedges, while numerous clumps of gray willows dot their shores. These lakes swarm with insect life and are apparently without fish, while the fourth lake is free of aquatic plants and is said to contain fish. This lake has few dragonflies. The three lakes supporting dragonflies were surprisingly warm. Expecting cold lakes at this altitude, I found the water too warm to drink with relish. This unusual warmth appeared to be due to the shallowness, the depth not exceeding three feet, and to the black peaty mud covering the bottom, which combination with the constant clear weather in this region during the summer months caused the lake water to heat rapidly from the sun's rays. At this elevation the air was so cool that *Aeshna* was easily taken on the wing and in two days' collecting I succeeded in catching 60 males and 28 females.

This species emerges from these lakes in immense numbers. I have never seen *Aeshna* exuviae so numerous. At the lake about which I did most of my collecting there was a zone of sedges 5 to 25 feet wide along the shore. The majority of the sedge stems were riddled with eggs, and exuviae hung frequently two or three deep on the prominent ones. I picked nearly a quart from an area about 15 feet square. While adults swarm over these ponds, they are not one-tenth as abundant as the exuviae, a fact explained by the wandering proclivities of both males and females.

As far as is known, those species of *Aeshna* which have been observed have emerged in the nighttime. I have reared both *multicolor* and *californica*, which emerge about midnight, but this species on these lakes, where the night temperature usually approaches freezing, emerges in the daytime. I found many teneral and took ten individuals in the act of emerging, which occurred at any time from 10 in the morning to 4 in the afternoon. This change in the time of emergence, perhaps, permits this species to live at this altitude, a thousand feet higher than I took any other species of *Aeshna*; and a true alpine habitat with nightly freezing temperatures.

At my earliest arrival on the lakes (10 in the morning) females were ovipositing and males were circling the borders of the lakes catching insects and watching for females, which were usually captured while ovipositing. The males, while around the lakes, usually flew at a height of from 1 to 4 feet above the sedge border, gradually

making their way around the lake in a series of short beats, which if plotted would show a series of loops overlapping, but each in advance of the preceding with occasional side flights after passing females and insect prey. Because of this habit of circling the edge of the lake, which was more pronounced in the morning while the sexual impulse was strong, I caught the majority of my specimens by standing in one place and catching the individuals on the wing as they passed.

In catching the females, the males would pounce down on them as they moved among the sedges from one oviposition to the next, or would themselves quietly drop, from their swifter coursing, down among the sedge stems and slowly work through the narrow channels until they found some female ovipositing. She would be seized, and the pair would dash away in a nuptial flight, which soon ended in a long rest in copulation while hanging to a tree. Many pairs flew about the lakes with the male holding the females' head, but not in copulation. This was more common than usual in *Aeshna*, reminding one of *Celithemis* or *Anax junius*. The females oviposited below water, as is usual among *Aeshnas*, most of the ovipositing being done in *Carex* stems. The egg is illustrated in figure 382.

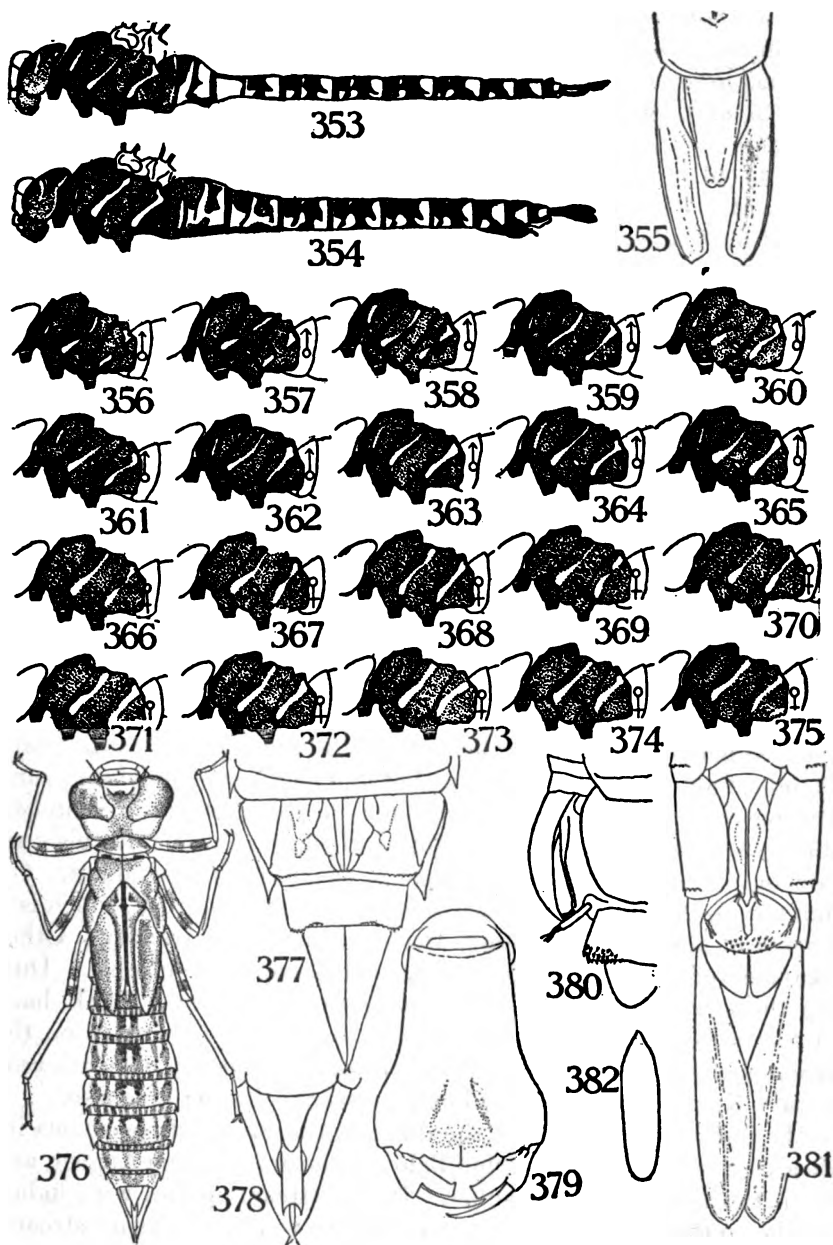
Females were common through the open places in the timber far from the lakes, where they were ranging for food, but while around the water their whole attention seemed to be concerned with ovipositing, except when males took them away in copulation.

Male.—The male of this species is easily distinguished from *interrupta interna* by the shape of the superior appendages (see fig. 355).

My field notes indicate that the pale colors are blue with the lower ends of the thoracic stripes paler but not distinctly yellow, while the dried material shows a majority of the specimens with lower end of thoracic stripes distinctly yellowish. (Fig. 353.) My impression is that the thoracic stripes were always blue in the male. The thoracic stripes varied remarkably from completely interrupted lateral stripes, which occurred in four of the sixty males, though various narrowly connected stripes of which there were about 12 resembling *lineata*, to the common form shown by the majority with the anterior stripe broad at the base and tapering to a point above, while the posterior stripe was moderately wide throughout its length. The figures 356–365 show these variations. In life the eyes were blue above and brownish or grayish below, with a narrow blue and black dash across the upper surface. The thorax was grayish brown, the abdomen black. The wings of the males were always hyaline.

Female.—I can not distinguish the female of *nevadensis* from several undoubted females I have of *interna*. Both blue and yellow females were taken on McKinney lakes. My field notes of July 28 give colors of 17 females taken that day as follows: One, all markings yellow, except the blue stripes in the brown eyes, wings strongly

flavescent to the stigmas; one with all markings yellow, except the blue eye stripes and the markings on segments 5-10 greenish, wings



FIGS. 353-382.—*AESCHNA INTERRUPTA NEVADENSIS*. 353-354. COLOR PATTERN. 355. MALE, APPENDAGES. 356-375. THORACIC COLOR VARIATIONS. 376-379. NYMPH. 377. VULVA. 378. MALE, APPENDAGES. 379. MENTUM. 380-381. SEGMENTS 9 AND 10 OF FEMALE. 382. EGG.

flavescent to stigmas; five with all markings pure blue; the other 10 with various intermediate colorations, the common form being

with greenish blue abdominal spots and the stripes on the thorax blue above and creamy yellowish below. The abdomen of the latter is brown shading darker caudad, the thorax brown, and the eyes grayish, never as blue as in the male. The females, whether yellow or blue, invariably had the blue dash in the eye. (See figs. 354, 366-375, and 380-381.)

Abdomen (without appendages), 45-47 mm.; appendages, 6; hind wing, 45-46.

Nymph.—I have not been able to distinguish the nymph from that figured by Walker¹ for *interrupta interrupta*. Some show the same color pattern as figured in his monograph, while others show each middorsal dark spot inclosing a pale spot as in my figure of *nevadensis* nymph. (See figs. 376-379.)

Length of body, 34 mm.; mentum, 6.5 long, 5.5 broad; hind wing, 9-10; hind femur, 6.5; inferior appendages, 4-4.5; genital valves, 2; width of head, 8; abdomen, 8.

16. A NEW SPECIES OF AESHNA—ITS NYMPH AND ITS HABITS.

This near relative of *palmata* was recorded first from Baja California by Calvert as *constricta*.² Walker in his monograph³ corrected this determination, placing part of Calvert's material under *palmata*, but noting the differences in coloration and structure between these Baja specimens and true *palmata*. As Walker had only males he deferred final judgment on the status of this form.

In the collection of Stanford University I found seven males of this species, which had been collected on the streams in Santa Clara County, California, during September and October of previous years. During these months in 1914 I was unable to collect, though on two different occasions I saw individuals, which were probably this species, on San Francisquito Creek west of the university buildings. On January 6, 1915, I found 14 exuviae on Los Trancos Creek, which is a stream of the Coast Mountains west of Stanford University. Other exuviae were collected on Arroyo Seco at Pasadena, California. During the summer of 1915 I collected nymphs in Mission Creek, back of Santa Barbara, California, and 16 males and 8 females on the streams of Santa Cruz Island, which lies 23 miles south of Santa Barbara. Numerous nymphs and exuviae were collected here also.

My few observations and the data on the Stanford specimens indicated that this species around Palo Alto emerges during August, and is on the wing until November. It is a stream species with habits similar to those of *palmata*. It inhabits the warmer frost-free streams

¹ The North American Dragonflies of the genus *Aeshna*. University of Toronto Studies, Biol. Series No. 11, 1912, pl. 6, fig. 2.

² Odonata of Baja California, Mexico. Proc. Cal. Acad. Sci., ser. 2, vol. 4, 1896, p. 508. Specimens from La Chuparosa, October, 1893.

³ North American Dragonflies of the Genus *Aeshna*, 1912, p. 164.

of the Coast Mountains, while *palmata* lives mostly on the colder streams of the Sierras. The ranges of the two species touch around San Francisco Bay. I have two female *palmata* from Stockton. A single female, which is probably *palmata*, was collected on Stevens Creek, Santa Clara County, California, which is only a few miles from Stanford. On this same creek I collected several exuviae of *walkeri*. These records from the neighborhood of Stanford are the northernmost records for *walkeri* and the farthest southwest records for *palmata*.

Since writing my first description of this species (not published) I found it very abundant on Santa Cruz Island, August, 1915. This mountainous island, 23 miles off the coast of California, contained no water except that found in the small, clear spring streams flowing down the narrow mountain gorges which opened to the sea at various points in the line of cliffs which surround it.

Aeshna walkeri was most abundant on the stream flowing down at Fry's Harbor. This stream was about 2 miles long and in that length fell over a thousand feet. It flowed down from Mount Diablo, a rocky crag rising to a height of about 3,000 feet. The canyon containing the stream was a V-shaped gorge a thousand feet deep with its sides covered with a thin growth of grass and scattering clumps of live oaks, where they were not too precipitous for vegetation.

Except in one or two places, either one or both banks of the stream were nearly vertical walls of rock and the course was broken every few hundred feet by a waterfall of from 10 to 40 feet. In places the stream was shaded by live oaks and alders, and here and there great clumps of green sword ferns, 7 feet high, gave a pleasing relief to the gray and brown of the naked rock. In several quarter-mile stretches the course of the stream was so deep that its bed was a fairly smooth trough of rock, being too steep to retain the rocks and sand washed down from above. Such stretches frequently contained pools, mere rock bowls, 6 to 10 feet in diameter, filled with water, in which green clouds of filamentous algae floated over the black leaves and vegetable trash in the bottom. Such pools were alive with tadpoles, *Aeshna walkeri* nymphs, and *Archilestes* nymphs. The upper half-mile of the stream was very stagnant, and here *Argia vivida* flourished. At no place in the stream did aquatic vegetation occur and in only a few places did roots hang in the water. Because of this lack of vegetation in which *Aeshna* usually oviposits, the habits of this species were unusual.

During the sunny part of the day the males are found coursing up and down the creek. As there is usually a morning fog on the island, which does not clear away until 9 o'clock, it is frequently 11 o'clock before the *Aeshna* males are on the creek. They then persist in flying up and down until the middle of the afternoon, when they leave the

water one by one to hunt insects in the sunshine above on the hill-tops. In the patrolling of the creek they combine feeding and hunting for females. A male will fly slowly along the rocky wall overhanging the water, inspecting every nook and cranny, and only give a hurried inspection to the open side of each pool. After being satisfied that he has not overlooked a female he will rise over the waterfall at the head of the pool and proceed to inspect, in the same manner, the stream above.

In a single afternoon's collecting I caught 14 males, which was probably a half of all living on the stream at the time, for in the next two days males were so scarce that I took only two more.

The females do not spend as much time on the creek as the males. Few were found on the creek before 3 o'clock, but when it had become almost twilight in the depths of the gorge they were nervously hurrying up and down the creek ovipositing. The method of this was so unusual that I did not recognize at first what they were doing. A female would alight on one of the rock walls overhanging a pool and would try to insert her ovipositor in the rock. After an attempt or two she would fly a few inches or feet and make another attempt. As the rocks over the pools in the shadier spots were seamed with lines of green moss, she would soon locate such a seam and drive her ovipositor into the vein of moss. The eggs thus were laid in the thin seam of moist earth which supported the moss. Usually less than a half dozen stabs would be made in one seam when she would fly to another and repeat the laying. In two places where tree roots hung into the water, females were flushed that were probably ovipositing in these. Oviposition was going on as late as 5 o'clock when it was almost twilight in the shadier portions of the gorge.

In copulation a male usually found a female while she was seated on a vertical wall of rock, and picking her off the two would fly away in copulation. This usually lasted some time while the pair hung to some live oak bush on the hillside. Pairs did not fly in couple as does *Anax*.

The nymphs were abundant in the shallow algae-filled pools, where they crawled slowly under and over the masses of green algae. One was observed eating a small tadpole of which there were many of at least two species in the stream.

This remarkable *Aeshna*, which is probably one of the last to be described from north of Mexico, I take pleasure in naming for Dr. E. M. Walker, who in his beautiful monograph of the North American species of this group has opened the way for future students.

AESHNA WALKERI, new species.

Length of abdomen, including appendages: Male (Palo Alto, California), 51-57 mm.; female (Santa Cruz Island, California), 56. Female appendages, 6 mm. Hind wing: Male, 43-47 mm.; female, 48.

Type.—Cat. No. 20817, U.S.N.M. A male from San Franciscoquito Creek, Santa Clara County, California.

No allotype has been named as I have no females from the same region as the male.

Structurally the males of this variety differ from *palmata* in the broader superior appendages with shorter preapical spines, and in the shorter anterior lamina and shorter anterior hamuli. (See figs. 385–386 and 395–396; also fig. 404, *constricta*.) As to the number of cells between A_2 and A_3 at their origin, four of the Stanford males have one cell in each hind wing and three have one cell in one hind wing and two cells in the other. This venational character is not reliable because it also varies in *palmata*, of which I have two males from the Sierras in each of which there are two cells between A_2 and A_3 at their origin.

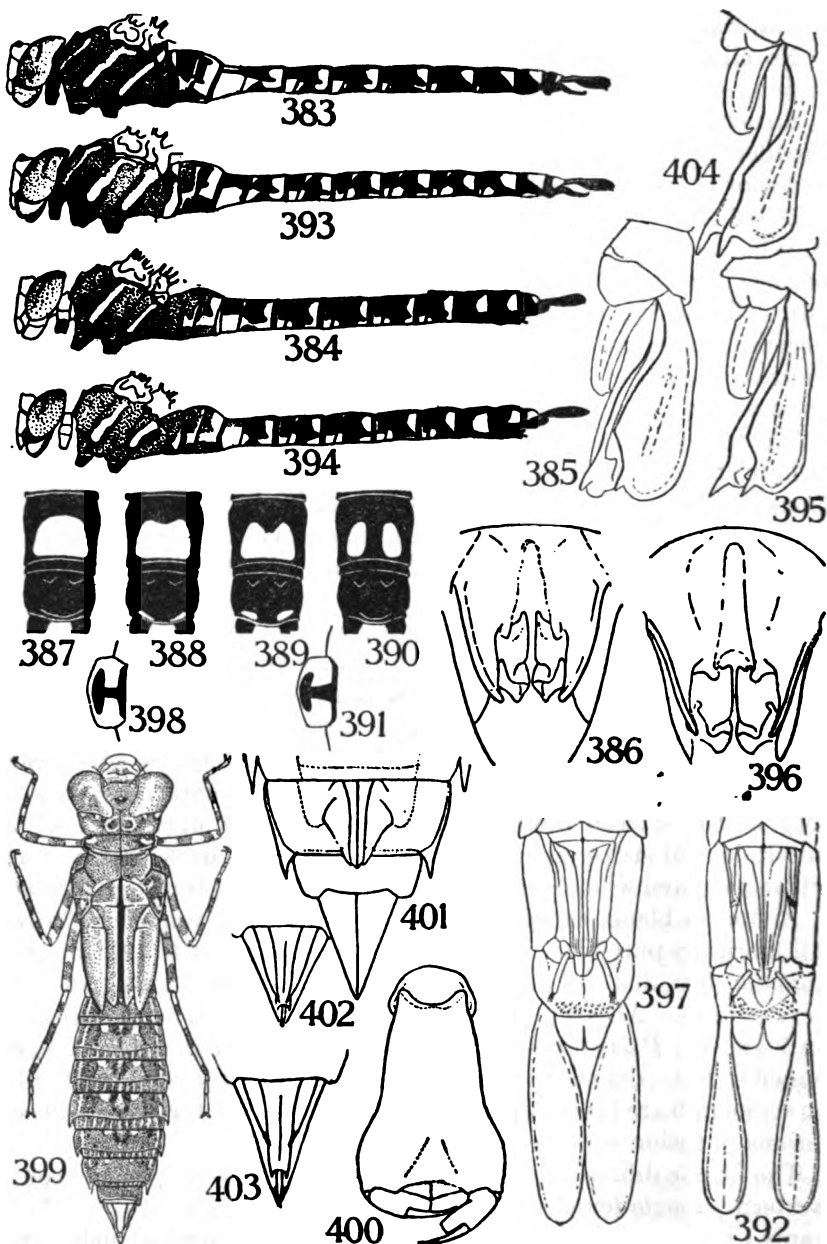
The live colors of the Santa Cruz Island males are as follows:

Labrum grayish white, face bluish gray, horizontal surface of frons creamy. Stem of "T" mark wide at base. Frontal vesicle and occiput creamy. Eyes gray above, pale gray below with a narrow blue dash backed by a narrow black line. Postocular areas black. (See figs. 383 and 391.)

Prothorax brown, with the anterior and posterior lobes paler. Mesothorax and metathorax dark brown. Anterior stripes pale blue and at antealar sinus two-thirds as wide as the lateral stripes, tapering regularly to the mesostigmal ridge. Lateral stripes whitish, blue-gray, very slightly bluer above. Both lateral stripes with nearly straight parallel edges, 1–1.2 mm. wide. This character varies, as four of the sixteen Santa Cruz males have the upper end of the antero-lateral stripe slightly sinuous. Legs very dark brown except tibiae and tarsi which are black. Wings hyaline; pterostigmas black.

Abdomen black, except segments 1 and 2, which are dark brown. All markings pure blue. The color pattern is similar to that on male *palmata* (figs. 393 and 398) except that ML is present only to 6 and is very minute. AL decreases rapidly in size from 3–8, being very small on 7 and 8. PL is present only to 5 or 6 and when present is broadly joined to PD. On all the Santa Cruz Island males the right and left PD on segment 9 are broadly joined. In the seven Stanford males all conditions of fusion were present (see figs. 387–390).

The female differs but slightly from that of *palmata*. In my southwestern *palmata* females (from Auburn, Stockton, and Stevens Creek, Santa Clara County) the anterior edge of the posthumeral pale stripe is distinctly sinuate as also in a female from Sunnyside, Washington. In *walkeri* females, of which I have eight from Santa Cruz Island, this anterior edge is either straight or slightly convex. The pterostigmas are black while in the western *palmata* females these are brown. The appendages are more spatulate than in *palmata* and the occiput is only half as large. (See figs. 392 and 397.)



FIGS. 383-392.—*AESHNA WALKERI*. 383-384. COLOR PATTERN. 385. MALE, APPENDAGES. 386. HAMULES. 387-390. COLOR, SEGMENTS 9 AND 10 OF MALE. 391. FRONS. 392. FEMALE, SEGMENTS 9 AND 10.

FIGS. 393-398.—*AESHNA PALMATA*.

FIGS. 399-402.—*AESHNA WALKERI*, NYMPH. 400. MENTUM. 401. VULVA. 402. FEMALE, APPENDAGES.

FIG. 403.—*AESHNA PALMATA*, NYMPH, FEMALE APPENDAGES.

FIG. 404.—*AESHNA CONSTRICTA*, MALE APPENDAGES.

The live colors of the Santa Cruz Island females are as follows:

Labrum grayish white, face pale brown, dorsal surface of frons creamy, stem of the "T" mark wide at the base. Frontal vesicle and occiput creamy. Eyes dark brown, paler and more grayish below, with a blue and black dash. Postocular area entirely black. (See fig. 384.)

Prothorax dark brown, the anterior and posterior lobes paler. Mesothorax and metathorax dark brown (not as dark as in the male). The anterior stripes mere blue lines. Lateral stripes as in the male, but the anterior not sinuous on its anterior edge, color a pale blue-gray, very slightly bluer above; both stripes bordered on each side by very dark brown. Both stripes run up onto the wing sclerites. The posterior edge of the dorsal end of the anterior lateral stripe is extended caudad more or less distinctly for the width of the stripe along the alar ridge. But little variation in thoracic color occurs among the eight females caught. Wings with stigma very dark brown, black except on a very close inspection; costal half of wing membrane flavescent as far as stigma, posterior to which it is more intense than elsewhere. Legs with coxae, trochanters, and femora dark brown, tibiae and tarsi black.

Abdomen dark brown, becoming darker caudad so that segments 8-10 are nearly black; appendages black. One female was taken in which the abdominal markings were blue; in the others they were yellowish olive green. None with pure yellow markings were seen.

The abdominal markings are similar to those of the male. From those of the female *palmata* (fig. 394) they differ in having a minute AD present on segments 3-7, in having PL present on segment 7, and in having PL and PD connate on all segments on which both occur. There are no blue markings on the ventral surface of the abdomen.

Nymphs.—Two females. Length of body, 34-37.5 mm., labium, 6.5-7, hind femur, 6.5-7; hind wing, 7.5-8; head, 8-9. Width of abdomen, 7-8 mm. (See figs. 399-402.)

The nymphs show a combination of *umbrosa* and *palmata* nymphal characters. The shape of the labrum is intermediate between that of *umbrosa* and *palmata*, its apical breadth between two-thirds and three-fourths of its length; but the lateral lobes have no internal distal tooth, thus resembling *palmata*. The dorsal paired appendages are almost as long as or, in one specimen, slightly longer than the middle appendage. In the specimen having the shortest dorsal appendages these were four-fifths as long as the middle appendage. In this character it differs from both *umbrosa* and *palmata* (fig. 403), as in both of these the dorsal appendages are only two-thirds as long as the middle appendage. In the female nymphs the genitalia extend under the anterior fourth or third of segment 10. The coloration in all the exuviae is very dark, the legs especially being very vividly banded, both on the femur and tibia.

These nymphal skins were collected January 6, 1915, on the roots and trunks of alder trees overhanging Los Trancos Creek where they had been probably since the preceding August.

17. SOME LISTS OF ODONATA COLLECTED IN NEVADA AND CENTRAL CALIFORNIA DURING 1913 AND 1914.

The following pages are devoted to lists by localities of Odonata collected in California and Nevada by the writer during the summer of 1914.

My collecting in California comprised three trips. One during June up the Napa River and up the Sacramento Valley to Tehama, one during July up the American River and about Lakes Donner and Tahoe, and a third during September up the San Joaquin Valley to Bakersfield, thence to the vicinity of Los Angeles.

Because of its great length north and south, because one border is on the coast and one on the desert, and because its great Sierra holds many northern forms, California has the richest odonate fauna of any of the Western States.

Faunistically the State can be roughly divided into three sections, though these are nowhere sharply defined. The entire western border of the State for a width of from 50 to 100 miles is occupied by the Coast Ranges. These are mainly north and south ridges of about the size and appearance of the Alleghanies of the eastern United States. In the north these are heavily timbered. In the central parts of the coast the timber is light, and on the east slopes replaced by brush (chaparral), while in the south, Los Angeles and vicinity, the timber is found only in the narrow canyons. Throughout the entire length of these Coast Ranges are numerous perennial streams, but in the southern half of these mountains many of these streams are dry beds of white sand in their lower courses during the dry season. This coast region is characterized by several local coast species.

The second great region is that of the valleys of the Sacramento and San Joaquin. As these rivers empty into the Bay, their valleys are connected by the Bay region and become a continuous plain 300 miles long and in places 50 miles broad. This is more level than a Kansas prairie and is a dry region with summer temperatures of 90° to 120° F. It is farmed largely to grains and its cities are walled about by great dykes, as it is subject to floods when the snows melt in the mountains each spring. It is characterized by several Mexican species which here reach their northernmost limits.

The third region is that of the great Sierra Range, which runs for the greater length of the eastern side of the State. The passes over this are from 7,000 to 8,000 feet above sea level and its snow peaks tower from 11,000 to 14,000 feet. The west slope is 50 miles wide, but yet so steep that the numerous rivers come down through can-

yons from 1,000 to 3,000 feet deep. This west slope is a dry region, except in the bottoms of the canyons, and has a fauna similar to that of the Coast Ranges, but at an elevation of about 4,000 feet this begins to give place to the purely Canadian fauna of the crest of the range. Here, at elevations of 6,000 to 10,000 feet, are found many species which flourish at sea level in British Columbia. It is in this Sierra region that several of these species reach their southernmost ranges.

The entire northern third of the State is unexplored as far as its dragonflies are concerned. The southeastern part of the State has a fauna which resembles that of the interior valleys, but is more strongly Mexican.

PALO ALTO, SANTA CLARA COUNTY, CALIFORNIA.

Palo Alto and Stanford University are situated on the flat at the southern end of San Francisco Bay. This is a plain dotted by the rich green of numerous low, round-topped live oaks and, except for artificial reservoirs, is dry from April to December of each year. Five miles west of the University the rolling dark green slopes of the Coast Range rise to an altitude of 2,000 feet. These are covered by conifers on their west slopes and in the deep moist canyons, but on their drier eastern side the redwoods and firs give place to scrub oaks, laurels, and dense brush. Numerous perennial torrents rush down through the heavy shade of the alders in the narrow winding gorges of these mountains to sink into the sand of their dry beds in the lower foothills, or to be dammed up and led away in irrigation pipes. Hidden away on the high slopes of the mountains are various spring-fed dams made to water stock, which have a more abundant dragonfly fauna than the ponds of the flat below. Such are the "Mud Lakes" of Stanford students, which lie at an elevation of 1,400 feet on the ridge between Corte de Madero and Los Trancos Creeks.

1. *ARCHILESTES CALIFORNICA* Mc Lachlan.

Many specimens in the Stanford collection. Probably on all large ponds in the fall. I have not collected about Stanford at this season.

2. *LESTES* CONGENER Hagen.

Occasional on all ponds.

3. *LESTES* DISJUNCTUS Setys.

On the mountain ponds. Specimens from the Coast Range have the pterostigmas black, the humeral stripe blue and little or no black on or posterior to the second lateral suture. The appendages are identical with eastern *disjunctus*.¹

¹ Specimens from the Lake Tahoe region have a broad stripe on the second lateral suture. Specimens from Washington and Oregon are as black on the sides as those from the Eastern States. One Oregon male has the thorax entirely black.

4. LESTES STULTUS Hagen.

Very abundant on the "Mud Lakes"; emerging during June (see page 484).

5. LESTES UNGUICULATUS Hagen.

Occasional on the mountain ponds.

6. ARGIA VIVIDA Hagen.

Common about all perennial springs.

7. ENALLAGMA CALVERTI Morse.

Occasional on Felt Pond during May and June, also on "Mud Lakes."

8. ENALLAGMA CARUNCULATUM Morse.

Common on all ponds and streams except the mountain torrents.

9. ENALLAGMA CYATHIGERUM (Charpentier).

Common on all streams and ponds except the mountain torrents.

10. ENALLAGMA PRAEVARUM (Hagen).

Occasional on all lowland streams and ponds. Common at "Mud Lakes."

11. TELEBASIS SALVA (Hagen).

Occasional about ponds.

12. ZONIAGRION EXCLAMATIONIS (Selys).

Common in the outlet to Searsville Lake. Occasional on ponds.

13. ISCHNURA CERVULA Selys.

Common on all ponds. The females colored like the males are common in this locality. The females are very definitely dichromatic.

14. ISCHNURA ERRATICA Calvert.

Occasional about ponds. Most often taken on the westernmost of the "Mud Lakes."

15. ISCHNURA PERPARVA Selys.

Common about all ponds and stagnant streams. The local males have less yellow on the abdomen than Oregon and Washington males.

16. CELAENURA DENTICOLLIS (Barmeister).

Occasional on ponds.

17. CELAENURA GEMINA Kennedy.

One male, Sharon Pond.

18. CORDULEGASTER DORSALIS Hagen.

On all perennial mountain torrents (see p. 515).

19. GOMPHUS SOBRINUS Selys.

A stray female was taken on Felt Pond in April, 1914 (see p. 558).

20. OCTOGOMPHUS SPECULARIS (Hagen).

On all perennial mountain torrents (see p. 574).

21. ANAX JUNIUS (Drury).

Occasional on the larger ponds.

22. AESHNA CALIFORNICA Calvert.

Common about ponds from April till July.

23. AESHNA MULTICOLOR Hagen.

Common from May to September.

24. *AESHNA WALKERI* Kennedy.

Common on San Francisquito and other creeks from August to November.

25. *LIBELLULA FORENSIS* Hagen.

Common on ponds and stagnant streams.

26. *LIBELLULA PULCHELLA* Drury.

Occasional on ponds.

27. *LIBELLULA SATURATA* Uhler.

Common on all ponds.

28. *PLATHEMIS LYDIA* (Drury).

Common on all ponds.

29. *ERYTHEMIS SIMPLICICOLLIS* (Say).

Common on all ponds.

30. *SYMPETRUM CORRUPTUM* (Hagen).

Common on ponds. This is on the wing from the latter part of February till December.

31. *SYMPETRUM ILLIOTUM* (Hagen).

The most common *Sympetrum*. This has also a long season, March till November.

32. *SYMPETRUM MADIDUM* (Hagen).

Common on the mountain ponds, emerging in June.

33. *PACHYDIPLAX LONGIPENNIS* (Burmeister).

On Felt Pond.

34. *TRAMEA LACERATA* Hagen.

On Sharon Pond.

STEVENS CREEK, SANTA CLARA COUNTY, CALIFORNIA.

The upper 10 miles of this creek is a clear, swift mountain stream. During the rainy season it empties into San Francisco Bay, but from June to December there is no water in its lower more level course. It comes down through a narrow gorge, and is heavily shaded by alders and bay trees.

1. *ARGIA VIVIDA* Hagen.

Occasional about springs along the lower course of the creek.

2. *CORDULEGASTER DORSALIS* Hagen.

Common on the swift upper end of the creek (see p. 515).

3. *OPHIOGOMPHUS BISON* Selys.

One specimen was seen near the Trout Farm.

4. *OCTOGOMPHUS SPECULARIS* (Hagen).

Common on the swift upper end of the creek.

5. *AESHNA PALMATA* Hagen.

One female was taken in August near Soda Spring. This is the farthest southwest record for the species.

6. *AESHNA WALKERI* Kennedy.

Common along the creek (see p. 586).

7. *SYMPETRUM ILLIOTUM* (Hagen).

Two seen below the Trout Farm.

SAN JOSE, SANTA CLARA COUNTY, CALIFORNIA.

San Jose is on the flat land at the extreme southern end of San Francisco Bay. The collecting was done along Coyote Creek, a sluggish mud-banked stream flowing through the city.

1. *HETAERINA AMERICANA* (Fabricius).

Four specimens taken May 16, 1914.

2. *ARCHILESTES CALIFORNICA* McLachlan.

Nymphs common. Have not collected at this place later than July 4.

3. *HYPONEURA LUGENS* Hagen.

One specimen taken. Not common.

4. *ARGIA AGRIOIDES* Calvert.

Abundant during July when stream is most stagnant.

5. *ARGIA VIVIDA* Hagen.

Not common.

6. *ENALLAGMA CARUNCULATUM* Morse.

Common.

7. *ENALLAGMA CYATHIGERUM* (Charpentier).

Common.

8. *ENALLAGMA PRAEVARUM* (Hagen).

Not common.

9. *TELEBASIS SALVA* (Hagen).

Common.

10. *ZONIAGRION EXCLAMATIONIS* (Setys).

Occasional during May and June.

11. *ISCHNURA CERVULA* Setys.

Abundant.

12. *ISCHNURA PERPARVA* Setys.

Common.

13. *CELAENURA DENTICOLLIS* (Burmeister).

Occasional.

14. *CELAENURA GEMINA* Kennedy.

Pair in copulation.

15. *PROGOMPHUS BOREALIS* McLachlan.

Two seen.

16. *GOMPHUS SOBRINUS* Setys.

Very abundant during May, 1914; none seen during May, 1915; this probably due to late rains (see p. 530).

17. *ANAX JUNIUS* (Drury).

Occasional.

18. *AESHNA CALIFORNICA* Calvert.

Abundant during May.

19. *AESHNA MULTICOLOR* Hagen.

Abundant during summer.

20. *MACROMIA MAGNIFICA* McLachlan.

Abundant during May, 1914. These emerged in numbers, the exuviae being common in the grass roots two feet above the stream. In 1914 the emergence took place before May 10. Few were seen in 1915.

21. *LIBELLULA SATURATA* Uhler.

Common.

22. *PLATHEMIS LYDIA* (Drury).

Common.

23. *ERYTHEMIS SIMPLICICOLLIS* (Say).

Common.

24. *SYMPETRUM CORRUPTUM* (Hagen).

Occasional.

25. *SYMPETRUM ILLIOTUM* (Hagen).

Common.

SAN LORENZO RIVER, SANTA CRUZ, CALIFORNIA.

This is a stream less than 20 miles long, which flows down the heavily timbered west slope of the Coast Range and empties into Monterey Bay at the town of Santa Cruz. I collected on Zyante Creek, where I saw no imagoes but found every stream-side tree and log covered with the exuviae of *Octogomphus* and *Cordulegaster*. The adults of these had evidently migrated farther up stream. The other species were taken on the San Lorenzo in the rocky gorge between Big Trees and Rincon, the best collecting being in the vicinity of Rincon. Probably the best collecting in the San Lorenzo is in the open valley towards Felton, above Big Trees, which part of the stream I did not visit.

1. *HETAERINA AMERICANA* (Fabricius).

Common below Big Trees.

2. *ARGIA EMMA* Kennedy.

Common from Big Trees to Rincon.

3. *ARGIA VIVIDA* Hagen.

Occasional below Big Trees.

4. *ENALLAGMA CARUNCULATUM* Morse.

Occasional below Big Trees.

5. *ENALLAGMA CYATHIGERUM* (Charpentier).

Common below Big Trees.

6. *ENALLAGMA PRAEVARUM* (Hagen).

Occasional below Big Trees.

7. *ZONIAGRION EXCLAMATIONIS* (Selys).

Common below Big Trees.

8. *CORDULEGASTER DORSALIS* Hagen.

Exuviae very abundant on middle reaches of Zyante Creek. No imagoes seen at all and no exuviae found below the swift water in the Zyante. The imagoes had emerged and evidently migrated farther up the creek.

9. OPHIOGOMPHUS BISON Setya.

Two specimens were taken on a small gravel bar in the San Lorenzo at Big Trees, where two exuviae were found on the base of an alder overhanging the stream. Two other imagoes were taken on a riffle at the Rincon powder works. These catches are interesting in that this species had been known only from a female, the type, which, deposited in the McLachlan collection, was labeled "from Santa Cruz, California." Probably the type had been taken on the San Lorenzo River.

10. OCTOGOMPHUS SPECULARIS (Hagen).

The exuviae of this species were abundant with the *Cordulegaster* exuviae on the middle reaches of Zyante Creek, but none were seen below this and no imagoes were seen.

11. AESHNA CALIFORNICA Calvert.

Several were seen above Rincon.

12. AESHNA MULTICOLOR Hagen.

Several seen along the railroad above Rincon.

LOS GATOS RIVER, SANTA CLARA COUNTY, CALIFORNIA.

Excepting for *Argia vivida* Hagen and a few *Cordulegaster* and *Octogomphus* on its headwaters, this stream is practically without Odonata. This is because of the very dense shade on the upper part of the stream, and the fact that so much water is removed by irrigation and for the town of Los Gatos that in any ordinary season the river is entirely dry in its open portion below Los Gatos.

From June 6 to 9 I collected at points on the Napa River. This small river, lying entirely in Napa County, drains a shallow valley on the north side of San Francisco Bay. This valley, lying just east of the main range of the Coast Mountains, is rather dry so that it resembles the Sacramento Valley. At Napa, where the first collections were made, the river is a tide stream and gave no Odonata. At Calistoga, the only other place examined, the river was also without Odonata.

NAPA, NAPA COUNTY, CALIFORNIA.

The collecting at Napa was done on the extensive estate of the Insane Hospital. A small, clear mountain stream, which comes down through a deep ravine east of the asylum, is led into a series of ponds and reservoirs. These swarm with Odonata.

1. ARCHILESTES CALIFORNICA McLachlan.

The shallows about the main pond swarmed with the nymphs of this. One teneral was taken.

2. LESTES, species.

This species was common on the pond.

3. ARGIA VIVIDA Hagen.

Common along the lower half of the stream.

4. *ENALLAGMA CARUNCULATUM* Morse.

On the "Fire Pond."

5. *ENALLAGMA CYATHIGERUM* (Charpentier).

Common on streams and all ponds.

6. *ISCHNURA CERVULA* Selys.

On "Fire Pond."

7. *ISCHNURA PERPARVA* Selys.

On all ponds.

8. *CELAENURA DENTICOLLIS* (Burmeister).

On "Fire Pond."

9. *CORDULEGASTER DORSALIS* Hagen.

On the mountain stream, where both imagoes and exuviae were collected.

10. *GOMPHUS SOBRINUS* Selys.

Several were caught on the largest pond.

11. *OCTOGOMPHUS SPECULARIS* (Hagen).

Common on the stream where several were taken while seated on rocks or foliage in the sunny openings.

12. *ANAX JUNIUS* (Drury).

A single female caught on one of the ponds.

13. *AESHNA CALIFORNICA* Calvert.

Abundant about the ponds.

14. *AESHNA MULTICOLOR* Hagen.

Common.

15. *MACROMIA MAGNIFICA* Mc Lachlan.

One male caught on the largest pond. This was the only individual of this species seen.

16. *TETRAGONEURIA CANIS* Mc Lachlan

These were very abundant on the largest ponds. This is the only place in the west at which I have taken this species though it has been recorded from the State of Washington.¹

The individuals flew slowly and dodged awkwardly and always stayed in loosely organized flocks, the individuals in which flew in short (40 feet) frequently changed beats. During windy weather they flew in a protected ravine opening onto the pond and at such times flew close to the ground so that they were easily caught. Early in the morning (9 o'clock) many spent much of their time perched on low bushes. When the wind was down they flew above the tree tops. These flocks were composed of males and females in about equal numbers and all were intent on catching the various minute insects filling the air. While many flew over the surface of the water their presence there appeared to be for food rather than a flight of the males hunting ovipositing females. During the two days collecting I saw no females ovipositing and no pairs in copulation. However the gelatinous strings of eggs were abundant in the

¹ Muttkowski, Catalogue of the Odonata of North America, p. 125.

Potamogeton in the edge of the pond. I collected about eighty individuals which seemed to reduce the abundance a third or a half. Several exuviae were found clinging to stones about 4 feet above the water. These I have misplaced or lost.

In life the eyes of the male were bright green above and gray below; those of the female less green above and gray below.

17. *LIBELLULA FORENSIS* Hagen.

On the "Fire Pond."

18. *LIBELLULA SATURATA* Uhler.

On all ponds.

19. *PLATHEMIS LYDIA* (Drury).

On the small "Fire Pond."

20. *ERYTHEMIS SIMPLICICOLLIS* (Say).

On the "Fire Pond."

21. *SYMPETRUM CORRUPTUM* (Hagen).

On all ponds.

22. *SYMPETRUM ILLIOTUM* (Hagen).

On the largest pond.

23. *SYMPETRUM PALLIPES* (Hagen).

Occasional.

CALISTOGA, NAPA COUNTY, CALIFORNIA.

The Napa River at this point is a small, sluggish stream and seemed to contain no Odonata. The collecting was done in the streams from a group of warm springs in the fields east of the town. Several acres of flat land at the foot of the low hills on the east side of the narrow valley fairly oozed warm water. The larger springs were so hot that they contained no life. Ditches had been dug in different directions through this boggy area for drainage. In these the water varied from tepid to cool and supported various species of Odonata. Several days of rain had very evidently reduced the collecting at this point.

1. *ENALLAGMA CYATHIGERUM* (Charpentier).

Occasional.

2. *ENALLAGMA CARUNCULATUM* Mene.

3. *ISCHNURA CERVULA* Selys.

Occasional about the cooler water.

4. *ISCHNURA PERPARVA* Selys.

Common.

5. *CELAENURA DENTICOLLIS* (Burmester).

The most abundant species. For habits see page 500.

6. *AESHNA CALIFORNICA* Calvert.

Seen.

7. *AESHNA MULTICOLOR* Hagen.

Several seen. One taken.

8. *LIBELLULA FORENSIS* Hagen.

Occasional.

9. *LIBELLULA SATURATA* Uhler.

Common. Many females of this species were found dead in the hot stream flowing from the largest spring. Perhaps they had tried to oviposit here, as the other streams were badly overgrown with vegetation.

10. *PLATHEMIS LYDIA* (Drury).

Common.

11. *ERYTHEMIS SIMPLICICOLLIS* (Say).

Abundant.

12. *SYMPETRUM CORRUPTUM* (Hagen).

Occasional.

13. *SYMPETRUM ILLIOTUM* (Hagen).

Common.

COLUSA, COLUSA COUNTY, CALIFORNIA.

From the Napa Valley I traveled up the Sacramento to Colusa, where I collected on June 11. This town is on the banks of the Sacramento, which is a navigable stream at this point. The bottoms here are many miles wide and being lower than the flood stage of the river, are traversed in various directions by dykes. These break up the natural drainage so that waste irrigating water has produced numerous more or less permanent sloughs.

1. *HETAERINA AMERICANA* (Fabricius).

Common among the willows fringing the river.

2. *LESTES CONGENER* Hagen.

Very abundant on the slough west of town.

3. *ARGIA EMMA* Kennedy.

Abundant on the banks of the river. The majority of the individuals were tenerals.

4. *ENALLAGMA CARUNCULATUM* Morse.

Common on the sloughs.

5. *ZONIAGRION EXCLAMATIONIS* (Setys).

Two males and one female on the river bank. Not abundant.

6. *ISCHNURA CERVULA* Setys.

Common on the sloughs.

7. *ISCHNURA PERPARVA* Setys.

Common on the sloughs.

8. *CELAENURA DENTICOLLIS* (Barmeister).

The most abundant species on the sloughs.

9. *OPHIOGOMPHUS OCCIDENTIS CALIFORNICUS* Kennedy.

Two males of this pale variety of *occidentis* were taken on the sandy bank of the river opposite the town. Exuviae were very abundant among the willows along the river (see p. 547).

10. *AESHNA MULTICOLOR* Hagen.

Common about the sloughs.

11. *LIBELLULA FORENSIS* Hagen.

Common on the sloughs.

12. *LIBELLULA SATURATA* Uhler.

Occasional.

13. *PLATHEMIS LYDIA* (Drury).

Common about the sloughs.

14. *ERYTHEMIS SIMPLICICOLLIS* (Say).

Abundant on the sloughs.

15. *SYMPETRUM CORRUPTUM* (Hagen).

Common on the sloughs.

16. *SYMPETRUM ILLIOTUM* (Hagen).

Occasional on the sloughs.

17. *PACHYDIPLAX LONGIPENNIS* (Burmeister).

One male was taken in the willows across the river from Colusa.

MARYSVILLE, YUBA COUNTY, CALIFORNIA.

Marysville is in the great Sacramento Bottoms on the Yuba River near its juncture with the Feather River. Marysville exists only through the protection of its great dykes. Hydraulic mining on the Yuba has filled the stream so full of tailings that it is but a shifting bed of white sand. Where at one time navigable, its bed is now above the level of the town of Marysville and the stream is wide and very shallow. This has killed any Odonata fauna it may have had at one time. The few species collected were taken in the sloughs back of the dykes across the bridge from the city.

1. *LESTES STULTUS* Hagen.

Several taken (see p. 484).

2. *ENALLAGMA CARUNCULATUM* Morse.

Not common.

3. *TELEBASIS SALVA* (Hagen).

One seen.

4. *ISCHNURA CERVULA* Selys.

Common; the most abundant species.

5. *ISCHNURA PERPARVA* Selys.

Common. Orange teneral females abundant.

6. *CELAENURA DENTICOLLIS* (Burmeister).

The second most abundant species.

7. *AESHNA MULTICOLOR* Hagen.

Several seen.

8. *LIBELLULA FORENSIS* Hagen.

Several seen flying with the next.

9. *PLATHEMIS LYDIA* (Drury).

Abundant.

10. *ERYTHEMIS SIMPLICICOLLIS* (Say).

Common.

11. *SYMPETRUM CORRUPTUM* (Hagen).

Very common. The most abundant large dragonfly. Emerging from the sloughs in large numbers.

OROVILLE, BUTTE COUNTY, CALIFORNIA.

Oroville is on the Feather River where it emerges from its canyon in the Sierras. This is a barren, dry, hilly region where farming is carried on by irrigation. It was on the irrigating and waste-water ditches across the river from Oroville that the following species were taken:

1. *HETAERINA AMERICANA* (Fabricius).

On irrigating ditch. Exuviae common.

2. *ARGIA AGRIODES* Calvert.

Several taken on irrigating stream.

3. *ARGIA EMMA* Kennedy.

One male taken on beach of Feather River.

4. *ARGIA VIVIDA* Hagen.

Abundant on a spring streamlet on side of Table Mountain.

5. *ENALLAGMA CARUNCULATUM* Morse.

Common.

6. *ENALLAGMA CYATHIGERUM* (Charpentier).

Occasional on the waste stream west of the Odd Fellows' Home.

7. *ISCHNURA PERPARVA* Selys.

Common.

8. *CELAENURA DENTICOLLIS* (Burmeister).

Several observed which were probably this.

9. *OPHIOGOMPHUS EISON* Selys.

Two males taken.

10. *OPHIOGOMPHUS OCCIDENTIS CALIFORNICUS* Kennedy.

One male taken.

11. *ERPETOGOMPHUS COMPOSITUS* Hagen.

One female, a teneral, was taken on the irrigating ditch across the river from Oroville. All the gomphines were taken on or near this ditch. As this water came from a tributary of the Feather River, probably the nymphs came down in the water. The Feather River was high and no Odonata except the *Argia* were seen on its banks.

12. *GOMPHUS SOBRINUS* Selys.

One male taken.

13. *ANAX JUNIUS* (Drury).

A pair were taken on the waste stream back of the Odd Fellows' Home.

14. *AESHNA MULTICOLOR* Hagen.

Common.

15. *MACROMIA MAGNIFICA* Mc Lachlan.

Two males and several exuviae seen.

16. *LIBELLULA COMANCHE* Calvert.

A single male, the only specimen I have ever seen alive, was caught while seated on the top of a weed near the waste stream. The fol-

lowing are live color notes: Eyes bluish gray, paler below; front of thorax dark pruinose blue-slate; sides of thorax and sides of segments 2 and 3 whitish.

17. *LIBELLULA FORENSIS* Hagen.

Several seen.

18. *LIBELLULA NODISTICTA* Hagen.

This was the most abundant species of this genus. Individuals were common on the side of Table Mountain, a half mile from water, where they spent most of their time seated on the dead branches of bushes scattered through the stunted Blue Oaks and Digger Pines. These were indolent and easily captured, but individuals flying about the waste-water stream were more wary.

19. *LIBELLULA PULCHELLA* Drury.

Several seen. Two captured.

20. *LIBELLULA SATURATA* Uhler.

Several were seen. Here I had an excellent opportunity to compare the habits of these species of *Libellula*. *L. saturata* was the most active and restless, *nodisticta* was most indolent, while *pulchella* and *forensis* had habits very similar.

21. *PLATHEMIS LYDIA* (Drury).

Several were observed.

22. *ERYTHEMIS SIMPLICICOLLIS* (Say).

Common.

23. *SYMPETRUM CORRUPTUM* (Hagen).

Common.

24. *SYMPETRUM ILLOTUM* (Hagen).

Common. With the last three species this is found close over the water as is also the next species.

25. *PACHYDIPLAX LONGIPENNIS* (Burmeister).

Several were taken at one spot on the waste stream back of the Odd Fellows' Home.

26. *TRAMEA LACERATA* Hagen.

A single male, the only individual seen, was captured on the side of Table Mountain.

CHICO RIVER, CHICO, BUTTE COUNTY, CALIFORNIA.

On June 14 and 15 I collected on the Chico River between the city of Chico and the mouth of the canyon 5 miles east of the city. The river was shallow because of much irrigating water withdrawn. It was very warm for the season, evidently carrying no snow water. The bottom was gravelly and the banks heavily shaded by brush and trees.

1. *HETAERINA AMERICANA* (Fabricius).

Very abundant.

2. *LESTES CONGENER* Hagen.

Common at the mouth of the canyon.

3. *HYPONEURA LUGENS* Hagen.

Very abundant in the mouth of the canyon. In ovipositing the male does not stand erect while attached to the female as does the male *Argia*. Oviposition is in any green branch lying in the running water.

4. *ENALLAGMA CARUNCULATUM* Morse.

Occasional.

5. *ENALLAGMA CYATHIGERUM* (Charpentier).

Occasional.

6. *ZONIAGRION EXCLAMATIONIS* (Selys).

One pair taken at the canyon.

7. *ISCHNURA CERVULA* Selys.

Scarce.

8. *ISCHNURA PERPARVA* Selys.

Several observed. Not as common as usual.

9. *PROGOMPHUS BOREALIS* Mc Lachlan.

Several males were taken. Difficult to approach.

10. *OPHIOGOMPHUS BISON* Selys.

Found on the same pools as the preceding but much less wary.

11. *GOMPHUS SOBRINUS* Selys.

A number were seen where the river ran through the city park. Evidently its season was almost over.

12. *OCTOGOMPHUS SPECULARIS* (Hagen).

Imagoes of this were not seen but the exuviae were very abundant in the mouth of the canyon.

13. *AESHNA MULTICOLOR* Hagen.

Not as common as usual.

14. *MACROMIA MAGNIFICA* Mc Lachlan.

Common. I took 12 of these in less than an hour where they were beating up and down a narrow lane. In the late afternoon this species loves to hunt away from the water.

15. *LIBELLULA SATURATA* Uhler.

Several seen.

16. *SYMPETRUM FALLIPES* (Hagen).

Not common.

17. *BRECHMORHOGA MENDAX* (Hagen).

Several individuals of this graceful species were seen. Two males and a female were taken. The males were taken while flying on short beats over the stream. The female was captured while cutting S's and figure 8's through a swarm of small Diptera. She was indifferent to several passes I made at her before I succeeded in netting her. This species is the most graceful on the wing of any odonate with which I am familiar. Frequently they fly with a swinging mayfly-like motion. In the heat of the day they floated around among the tree tops.

TEHAMA, TEHAMA COUNTY, CALIFORNIA.

On June 16 I tried collecting at Tehama, but the temperature was 112°, and both the Sacramento and Mill Creek (Los Molinas) were too high for collecting.

On July 15 I started on a collecting trip from Sacramento up the American River to Auburn across the Sierras to Lakes Donner and and Tahoe, thence to Reno. Pyramid Lake, and the Humboldt River in Nevada.

AMERICAN RIVER, SACRAMENTO, CALIFORNIA.

Sacramento lies at the juncture of the Sacramento and American Rivers. Here as far as the eye can see the valley is perfectly flat and is flooded annually by the Sacramento River. To one approaching Sacramento only the second stories of the houses and the tops of the numerous shade trees are visible for it is entirely surrounded by a great 20-foot dyke, through which the railroads enter by flood gates that can be closed in times of high water. The American River at the time of my visit was about 300 feet wide, with half the bottom exposed as sand bars; the 15-foot banks, as well as the entire bed, were composed of loose sand. Opposite the city, where I collected, the bottoms were a jungle of box elder trees about 30 feet high, except for a few cottonwoods along the bank and an occasional more open glade occupied by willows. The river itself, even among the cottonwood trees, was fringed with willows. The sloughs mentioned in the following list were in the bottoms back some distance from the river. No collecting was attempted on the Sacramento River at this place.

1. *HETAERINA AMERICANA* (Fabricius).

Not common. On river.

2. *LESTES CONGENER* Hagen.

Some about sloughs.

3. *ENALLAGMA CARUNCULATUM* Morse.

Common about sloughs.

4. *ISCHNURA CERVULA* Selys.

About sloughs.

5. *ISCHNURA PERPARVA* Selys.

About sloughs.

6. *OPHIOGOMPHUS OCCIDENTIS CALIFORNICUS* Kennedy.

One male taken in a willow glade opposite the city.

7. *GOMPHUS OLIVACEUS* Selys.

This species was very abundant on the American River opposite the city. None were found except in the half mile between the two railroad bridges. The males were abundant over the swift muddy water or resting on the overhanging willows. The females were caught in the willow glades back from the bank. (See page 554.)

8. *ANAX JUNIUS* (Drury).

About the sloughs.

9. *AESHNA MULTICOLOR* Hagen.

About the sloughs. This species was observed catching insects on the market street of the city at twilight. They flew among the wagons and buggies entirely indifferent to the numerous passers-by. This habit of familiarity with man's haunts is very noticeable in *multicolor*. It is the most domestic of all the western Odonata

10. *LIBELLULA FORENSIS* Hagen.

About the sloughs.

11. *LIBELLULA SATURATA* Uhler.

Common.

12. *PLATHEMIS LYDIA* (Drury).

On the sloughs.

13. *ERYTHEMIS SIMPLICICOLLIS* (Say).

Occasional on the sloughs.

14. *SYMPETRUM CORRUPTUM* (Hagen).

Common. This species throughout the Sacramento and the San Joaquin Valleys was widely scattered away from water.

15. *SYMPETRUM SEMICINCTUM* (Say).

About the sloughs.

16. *TRAMEA LACERATA* Hagen.

Several seen about the slough between the river and the city.

AUBURN, PLACER COUNTY, CALIFORNIA.

At Auburn I collected, July 18 and 19, in the small stream south of the town, which may be termed the "town drain," as it carried the sewage and run-off of the entire community; also on the American River, which at this place flows at the bottom of a V-shaped gorge over 1,000 feet deep. The sides of this canyon are scantily clad with digger pines and scrub oaks, and the stream, 200 feet wide and 3 feet deep, flows over a bed of hydraulic tailings, mainly drifting coarse gravel and stones of all sizes. A few spring streams trickle down the steep sides of the canyon.

1. *HETAERINA AMERICANA* (Fabricius).

Common along the river, apparently having emerged from the main stream.

2. *LESTES UNCATUS* Kirby.

Several captured on the "town drain."

3. *ARGIA AGRIOIDES* Calvert.

Common on the "town drain."

4. *ARGIA EMMA* Kennedy.

Occasional on the rocks below the dam in the river.

5. *ARGIA VIVIDA* Hagen.

Very abundant on the spring streams trickling down the sides of the gorge.

6. *ENALLAGMA CARUNCULATUM* Morse.

Common on the "town drain," where the next also occurred.

7. *ENALLAGMA CYATHIGERUM* (Charpentier).

Occasional along the edges of the river.

8. *TELEBASIS SALVA* (Hagen).

Occasional on the "town drain."

9. *ISCHNURA CERVULA* Setys.

On "town drain." Rare.

10. *ISCHNURA PERPARVA* Setys.

Tenerals common on "town drain."

11. *CORDULEGASTER DORSALIS* Hagen.

One male was seen at close range on the river bank. It was the only time I have seen this species except on or near swift mountain torrents. He persisted in alighting on various bushes and so may have been lost from his usual haunts.

12. *OPHIOGOMPHUS OCCIDENTIS CALIFORNICUS* Kennedy.

Three females were caught on the river bank below the dam. A fourth individual was seen. These were unusually yellow, the dark pattern being very pale and restricted (see p. 543).

13. *OCTOGOMPHUS SPECULARIS* (Hagen).

One male was seen at close range while he was seated. This was on a very small spring stream, the whole flow of which could pass through a 2-inch pipe.

14. *AESHNA MULTICOLOR* Hagen.

One male was taken. Several *Aeshna*, probably of this species, were seen.

15. *AESHNA PALMATA* Hagen.

One taken.

16. *MACROMIA MAGNIFICA* Mc Lachlan.

A male, the only one seen, was taken on the river above the dam.

17. *LIBELLULA NODISTICTA* Hagen.

Common on the "town drain." In the morning the individuals of this species were easily captured while seated on brush and weeds in the sunny openings along the stream. Copulation was as usual among *Libellula*. A female observed ovipositing flew about 2 feet above the water and made several quick swings downward, tapping the water with her abdomen just once for each swing. This species appears to have a restricted distribution in California. So far there are no records except for the foothills of the Sierra; in other words, a zone along the west side of the Sierras between about 500 feet altitude and 3,000 feet. It has not been recorded from the Sacramento or San Joaquin Valleys proper or from west of them, or from the wooded crest of the Sierras.

18. *LIBELLULA PULCHRELLA* Drury.

Several were taken about a pool on the river bank in the bottom of the gorge.

19. *LIBELLULA SATURATA* Uhler.

Occasional in the gorge with the preceding.

20. *PLATHEMIS LYDIA* (Drury).

Several were seen on a spring stream in the gorge.

21. *SYMPETRUM ILLOTUM* (Hagen).

Abundant on the "town drain." Usually the female of this species oviposits unaccompanied by the male but here I observed a pair working together. These copulated on the wing, then rested half a minute in copulation on a branch, when they flew about over the water, the male holding the female by the thorax, the pair making tentative dives from an elevation of about 2 feet. After a half minute they dropped 2 inches above the water when with a swinging motion the female dipped her abdomen in the water about 30 times, after which they made a sudden upward flight and separated, each to seat itself on a twig.

22. *SYMPETRUM SEMICINCTUM* (Say).

Common on the "town drain."

BEAR VALLEY, EMIGRANT GAP, PLACER COUNTY, CALIFORNIA.

On July 21 I collected in Bear Valley, which has an elevation of 4,500 feet, and lies about 1,000 feet below the railroad station of Emigrant Gap. This small valley is a hay meadow with a level floor about 1 mile long and a fourth mile broad. Bear Creek flows through it and where tributary streamlets cross it there is boggy ground. Such places contain willow thickets. The sides of the valley, where not occupied by granite outcrops, are covered by a sparse growth of cedar and fir interspersed with thickets of various shrubs.

1. *LESTES CONGENER* Hagen.

Common.

2. *LESTES DISJUNCTUS* Setyn.

Occasional.

3. *ENALLAGMA CARUNCULATUM* Morse.

Not common.

4. *ENALLAGMA CALVERTI* Morse.

Two collected.

5. *COENAGRION RESOLUTUM* (Hagen).

Several taken about a spring-fed pool.

6. *AMPHIAGRION SAUCIUM ABBREVIATUM* Setyn.

Not common.

7. *ISCHNURA CERVULA* Selys.

Not common. Several taken about the same pool as *Coenagrion*. One male had the front of the thorax solid black, no blue spots being present.

8. *ISCHNURA PERPARVA* Selys.

Occasional.

9. *CORDULEGASTER DORSALIS* Hagen.

One male taken. Several observed on the small spring streams tributary to Bear Creek. This is the highest (4,500 feet) and most easterly record for this species. This was a surprise, as I had associated this species with the warm torrents of the Coast Ranges. But while the railroad is protected with snowsheds at Emigrant Gap, which is 1,000 feet higher than Bear Valley, it is possible that the floor of the valley enjoys a warmer climate. The following species in this list would indicate a fairly moderate climate: *Enallagma carunculatum* Morse, *Ischnura cervula* Selys, *Ischnura perparva* Selys, *Cordulegaster dorsalis* Hagen, *Anax junius* (Drury), *Aeshna multicolor* Hagen, and *Libellula pulchella* Drury.

10. *ANAX JUNIUS* (Drury).

An *Anax* was observed patrolling a large pool in Bear Creek. Probably this species.

11. *AESHNA MULTICOLOR* Hagen.

One taken. Common.

12. *AESHNA INTERRUPTA NEVADENSIS* Walker.

Several observed. One teneral captured at the head of the valley.

13. *AESHNA PALMATA* Hagen.

Several were easily netted, as they flew in short beats among the willow thickets to escape the wind. This species in such a situation is very easily victimized by the collector. They fly low and slowly and are very bull-headed about keeping to their short protected beat, two or three passes with the net sometimes failing to drive one away.

14. *LIBELLULA PULCHELLA* Drury.

Several seen. One collected.

15. *LIBELLULA QUADRIMACULATA* Linnaeus.

Common. This was the lowest elevation at which I took this mountain species.

16. *PLATHEMIS LYDIA* (Drury).

Several seen. Two collected.

17. *SYMPETRUM OBTRUSUM* (Hagen).

Several collected. Not abundant.

18. *SYMPETRUM PALLIPES* (Hagen).

One male, a teneral, taken.

19. *SYMPETRUM SCOTICUM* (Donovan).

Several seen. Two taken.

20. LEUCORRHINIA GLACIALIS Hagen (?).

A Leucorrhinia was seen. Probably this.

The following series of lists are concerned with the drainage east of the crest of the Sierras. Two stream systems are included. Truckee River rises in Lakes Tahoe, elevation 6,000 feet, and Donner, elevation 5,000 feet. It flows down the abrupt east slope of the Sierras and empties into the salt Pyramid and Winnemucca Lakes in the Nevada desert. The other system concerned is that of the Humboldt River, which rises in the mountains in eastern Nevada and, flowing west, empties into the great shallow alkaline lake called Humboldt Sink. These are two fragments of the old Lake Lehontin System.

DONNER LAKE, NEVADA COUNTY, CALIFORNIA.

From July 23 to 26 I collected about Truckee and Donner Lake, which lies 3 miles west. This clear blue lake, 3 miles long and a half mile wide, when it mirrors in its glassy surface the green, pine-clad mountains which rise almost from its pebble beach, is one of the most beautiful of the Sierra lakes. The east shore is a gravel beach. This changes gradually into the cobble beach along its north shore, which again at its west end merges into a short pure sand beach. At its eastern end the lake drains by Donner Creek, which meanders through a series of green meadows into Truckee River. In this narrow valley, just east of the confluence of Donner Creek with Truckee River, lies the town of Truckee. In the spring-fed boggy meadow near the town slaughterhouse were collected various species mentioned below. This high mountain region is characterized by its Canadian dragonflies, but, oddly enough, it has with this fauna a few species usually associated with lower, warmer altitudes. These are discussed as they occur in the list.

1. LESTES CONGENER Hagen.

Common everywhere there is standing water, but not found in Donner Lake.

2. LESTES DISJUNCTUS Setys.

Several were taken in a bog pool near the outlet of the lake.

3. LESTES UNCATUS Kirby.

Common in all swampy places.

4. ARGIA EMMA Kennedy.

Several were taken in the outlet. Probably because of the size and depth of Donner Lake its waters keep the creek running during the winter. This and the next species were surprises from a warmer fauna.

5. ARGIA VIVIDA Hagen.

Abundant about the lake shore, where it breeds in the numerous spring streams crossing the beaches.

6. ENALLAGMA CALVERTI *Morse.*

Several were taken on the beach.

7. ENALLAGMA CARUNCULATUM *Morse.*

One male was found among *Enallagma* collected on the beach.

8. ENALLAGMA CYATHIGERUM (*Charpentier*).

This species lives in the lake and in places fairly swarms along the beaches.

9. COENAGRION RESOLUTUM (*Hagen*).

Several were taken around a boggy pool near the lake outlet.

10. AMPHIAGRION SAUCIUM ABBREVIATUM *Selys.*

Occasional.

11. ISCHNURA CERVULA *Selys.*

Abundant in the lily pads near the outlet of the lake.

12. ISCHNURA PERPARVA *Selys.*

With the preceding, but less common. These two are at the extreme upper limit of their range.

13. OPHIOGOMPHUS MORRISONI *Selys.*

This was very abundant along the north shore on the finer gravel and also around the outlet. Over a hundred specimens were taken (see p. 534).

14. GOMPHUS DONNERI *Kennedy.*

This was abundant on the sandy beach at the west end of the lake. Probably it was past its season, as only two females were caught. This species, which is closely related to *Gomphus sobrinus* Selys, seems to be either peculiar to this lake or a species not yet recorded from elsewhere. It is one of the surprises, as most *Gomphi* live in the larger, warm rivers. Probably this is the highest elevation (5,940 feet) at which the genus has been recorded in North America.

15. ANAX JUNIUS (*Drury*).

One individual was seen several times on Donner Creek near the outlet to the lakes. This is on the extreme upper limit of this species' habitat.

16. AESHNA PALMATA *Hagen.*

Three males of this were caught on Donner Creek. It was not abundant. Exuviae were found in Donner Creek.

17. AESHNA INTERRUPTA NEVADENSIS *Walker* (?).

Females of *Aeshna interrupta* Walker were taken near the outlet of the lake. Probably these were of the variety *nevadensis* Walker.

18. TETRAGONEURIA SPINIGERA *Selys.*

Several were caught on the Donner Lake road.

19. LIBELLULA PULCHELLA *Drury.*

Several caught on Donner Creek. This is near the upper limit of this species.

20. *LIBELLULA QUADRIMACULATA* Linnaeus.

Common about the outlet. This is the common *Libellula* at this high altitude.

21. *SYMPETRUM CORRUPTUM* (Hagen).

Several seen near the outlet to the lake.

22. *SYMPETRUM OBTRUSUM* (Hagen).

Several caught near the outlet. Abundant near the Truckee slaughterhouse.

23. *SYMPETRUM PALLIPES* (Hagen).

Several caught among the willow thickets near the outlet. Emerging in large numbers in the boggy meadow near the slaughterhouse. *Pallipes*, *scoticum*, and *obtrusum* seem to be able to live in mud.

24. *SYMPETRUM SCOTICUM* (Donovan).

Both mature imagoes and tenerals abundant near the slaughterhouse.

25. *LEUCORRHINIA GLACIALIS* Hagen.

One individual was caught near the outlet and three were taken near the Truckee slaughterhouse.

SQUAW CREEK AND TRUCKEE RIVER ABOVE DONNER CREEK, ELEVATION 6,000-6,500 FEET, PLACER COUNTY, CALIFORNIA.

1. *LESTES CONGENER* Hagen.

Not common.

2. *LESTES UNCATUS* Kirby.

Second most numerous species in Squaw Creek meadows.

3. *ARGIA EMMA* Kennedy.

Several taken on Truckee River near outlet of Lake Tahoe. This is the highest altitude for this species. It probably exists here because Tahoe does not freeze and so the Truckee River does not freeze.

4. *ARGIA VIVIDA* Hagen.

Occasional along the Truckee River. One or two were seen in the inlet at McKinney's Camp on Lake Tahoe. This is the highest California record for this species.

5. *ENALLAGMA CYATHIGERUM* (Charpentier).

Occasional in Squaw Creek meadows and on Truckee River.

6. *COENAGRION RESOLUTUM* (Hagen).

Occasional in Squaw Creek meadows.

7. *AESHNA INTERRUPTA NEVADENSIS* Walker (?).

Several female *interrupta* were taken along Truckee River, probably var. *nevadensis*. This species is abundant and in place at this altitude.

8. *AESHNA PALMATA* Hagen.

One male was seen at close range seated on a willow in Squaw Creek meadows. This as far as my data shows is the upper limit of

this species, excepting an exuvia, possibly of this species, found on McKinney Lakes, 7,000 feet altitude. *Palmata* certainly is not normally as common above 6,000 feet as below that height.

9. *SOMATOCHLORA SEMICIRCULARIS* (Selys).

Several were caught on sedgy sloughs along Squaw Creek and Truckee River. This is the lowest elevation at which I took this species in this region. In central Oregon (Bend) it is abundant at 4,000 feet, in Washington (Bumping Lake) at 3,500 feet, and in British Columbia at sea level.

10. *LIBELLULA PULCHELLA* Drury.

Two were seen on Squaw Creek. This is the highest record for this species in this region.

11. *LIBELLULA QUADRIMACULATA* Linnaeus.

Abundant over all marshes above 5,000 feet.

12. *SYMPETRUM RUBICUNDULUM DECISUM* (Hagen).

This brown faced species was the most abundant dragonfly on Squaw Creek.

13. *SYMPETRUM PALLIPES* (Hagen).

Emerging in numbers from grassy sloughs along Squaw Creek.

14. *SYMPETRUM SCOTICUM* (Donovan).

Occasional in Squaw Creek valley.

LAKE TAHOE, CALIFORNIA AND NEVADA.

This lake, 23 miles long by 10 broad, is surrounded by mountains, the lower slopes of those on the west shore covered by green pines, those of the east shore brown and barren. Its entire shore line, except for sand along the south shore and some bordering cliffs, is a clean pebble beach. Its water is marvelously clear. Fish are easily seen at a depth of 20 feet and every scratch in the paint on the keel of the lake steamer is so distinct that the boat gives one the idea of floating in the air. This lake is so deep that it does not freeze in winter. Its elevation is 6,225 feet.

Because of this unusual purity of the water and lack of mud on the beaches and bottom there is almost an entire absence of large aquatic vegetable life. Consequently all other forms of life based on this are in scanty numbers or entirely absent.

In three days collecting I saw only three species of dragonflies on the lake. *Argia vivida* Hagen occurred in a grassy inlet at McKinney. *Aeshna interrupta nevadensis* Walker was common but probably bred in the small lakes on the mountains about, and through its great propensity for wandering came to hunt along the Tahoe shores. *Ophiogomphus morrisoni* Selys was probably the only species actually spending its nymphal existence in the lake water. A single male which flew aboard the steamer in Emerald Bay is my only information on this species.

The United States Reclamation Service has recently dammed the outlet and raised the surface of the water several feet. This has covered many of the beaches and may account for part of the scarcity of aquatic insects.

AL TAHOE.

In the swamp at Al Tahoe at the southern end of the lake were taken *Lestes uncatus* Kirby, *Lestes congener* Hagen, *Lestes disjunctus* Selys, *Enallagma cyathigerum* (Charpentier), *Aeshna interrupta nevadensis* Walker, *Libellula quadrimaculata* Linnaeus, *Sympetrum obtrusum* (Hagen), *Sympetrum pallipes* (Hagen), and *Sympetrum corruptum* (Hagen).

MCKINNEY LAKES, MCKINNEY LANDING, LAKE TAHOE, ELEVATION 7,000 FEET.

Four small lakes lie on the divide between McKinney Creek, which flows into Tahoe, and the Rubicon River, which flows into the American River or Pacific drainage. All are glacial lakes filled by sediment until very shallow, three of them being covered by lily pads and not over 4 feet deep. The open lake contains fish and so has little insect life. The other three fairly swarm with Odonata, in spite of their elevation and the crags carrying snow patches, which rise on either side of them. The water of these is surprisingly warm, in fact much too warm to drink with pleasure. This unusual warmth in the lake water at this altitude is probably due to the fact that the lakes are very shallow and have black, peaty bottoms which, with the long, clear summer season, permit the sun to raise the temperature of the water. However, all the flourishing species are truly Canadian, even the hardiest of the lower forms existing at this elevation in scanty numbers.

1. *LESTES CONGENER* Hagen.

Not common. Three pairs taken.

2. *LESTES UNCATUS* Kirby.

Occasional.

3. *ENALLAGMA CYATHIGERUM* (Charpentier).

Rarely taken.

4. *COENAGRION RESOLUTUM* (Hagen).

This is the common damsel fly about the lakes.

5. *CORDULIA SHURTLEFFI* Scudder.

Common about the lakes.

6. *SOMATOCHLORA SEMICIRCULARIS* (Selys).

Common. This species is found only over patches of sedges standing in shallow water. Apparently the females oviposit in such sedge patches, and the males are there to find the females.

7. *AESHNA INTERRUPTA NEVADENSIS* Walker.

This is very abundant about two of these lakes. The exuviae hang on the sedges in vast numbers. (See p. 581.)

8. *AESHNA PALMATA* Hagen.

Among a series of exuviae collected here Dr. E. M. Walker found a single mutilated exuvia which he thought might be this species. No imagoes were seen. I doubt if it occurs other than as a straggler at this altitude.

9. *LIBELLULA QUADRIMACULATA* Linnaeus.

Common.

10. *SYMPETRUM OBTRUSUM* (Hagen).

One male caught. Rare.

11. *SYMPETRUM PALLIPES* (Hagen).

Not common.

12. *LEUCORRHINIA GLACIALIS* Hagen.

Fairly swarming over one of the lakes. The bushes about the shore were alive with pairs in copulation and numerous single individuals.

RENO, NEVADA.

Reno, at an elevation of 4,500 feet, lies in a small valley, whose level floor with its vivid green alfalfa fields is in striking contrast to the brown of the massive Sierra foothills which surround it. The Truckee River on its course eastward to the Nevada Desert passes through this valley but gives the most of its water to the irrigation canals which carry it to the alfalfa fields. Its bed is an almost continuous gravel bar and it supports but little odonate life. Back from the river are numerous sloughs of waste irrigating water, common in any overirrigated country, which fairly swarm with various pond species.

1. *LESTES CONGENER* Hagen.

Common about all sloughs.

2. *LESTES UNCATUS* Kirby.

Common about the sloughs.

3. *ARGIA EMIMA* Kennedy.

One pair of *Argia* was seen on the river near the Asylum. Probably this species.

4. *ENALLAGMA ANNA* Williamson.

This was the only *Enallagma* taken in the valley, though two others probably occurred there. I had an excellent chance to observe its habits. It was very active and flew busily back and forth along the flowing irrigating ditches. Copulation lasted several minutes. In ovipositing, the females painstakingly put their eggs into the submerged stems of aquatic plants, at which task they were usually accompanied by the males until there was danger of submergence, when these left the females to themselves. Frequently females would be submerged for many minutes. Nymphs were common among the *Potamogeton* stems in the more weedy ditches. A large series of this species was taken.

5. AMPHIAGRION SAUCIUM ABBREVIATUM Selys.

Only one was seen.

6. ISCHNURA CERVULA Selys.

Common in restricted areas.

7. ISCHNURA PERPARVA Selys.

Occasional.

8. OPHIOGOMPHUS MORRISONI Selys.

Four exuviae were found on a gravel bar of the river. This is a species of elevated districts. I have it from the Deschutes River, at Bend, Oregon, elevation 4,000 feet; from Donner Lake, California, elevation 5,940 feet; and from Lake Tahoe, California, elevation 6,225 feet. Farther east on the Truckee River than Reno Valley it is displaced by *Ophiogomphus morrisoni nevadensis* Kennedy. *Morrisoni* is apparently a species of the upper border of the Transition Zone. *Ophiogomphus morrisoni* and *Argia emma* were the only species found on the river in the Reno Valley.

9. AESHNA PALMATA Hagen.

Aeshna was very abundant over the areas of tules or cattails in the sloughs. All of those captured were of this species. Probably *constricta* Say and *interna* Walker occur in this valley also.

10. LIBELLULA FORENSIS Hagen.

Very common. This was the only *Libellula* seen.

11. SYMPETRUM CORRUPTUM (Hagen).

Common.

12. SYMPETRUM COSTIFERUM (Hagen).

One captured. Several seen.

13. SYMPETRUM RUBICUNDULUM DECISUM (Hagen).

Common. The white faced *obtrusum* was not observed.

14. SYMPETRUM PALLIPES (Hagen).

Several observed.

15. SYMPETRUM SCOTICUM (Donovan).

The most abundant species.

16. LEUCORRHINIA GLACIALIS Hagen.

The type of this species came from Reno, but I saw none. However, I collected over only a small portion of the valley.

LOWER TRUCKEE RIVER, NEVADA.

In the few miles before the Truckee River empties into Pyramid Lake it meanders as a strongly alkaline stream over numerous gravel bars through the rich bottom land occupied by the Piute Indians. The Truckee through its lower course is well shaded by cottonwoods, willows, and alders. My collecting at this point and on Pyramid Lake, 4 miles distant, was made possible through the kindness of Mr. Oliver, the Indian agent, at whose home I stayed while there.

1. LESTES CONGENER Hagen.

Common in the willows.

2. *ARGIA EMMA* Kennedy.

Common. Exuviae numerous about the roots of trees overhanging the water.

3. *ENALLAGMA CARUNCULATUM* Morse.

Common.

4. *ISCHNURA CERVULA* Setys.

Abundant in sedgy spots. Local in its distribution.

5. *OPHIOGOMPHUS MORRISONI NEVADENSIS* Kennedy.

This was the first place I took this large yellow *Ophiogomphus*. It was associated on the riffles with the next species, the two species having identical habits. I saw a female ovipositing on a riffle, striking the water with her abdomen as she flew along (see p. 536).

6. *ERPETOGOMPHUS COMPOSITUS* Hagen.

This widely spread species occurred sparingly on the riffles of the lower Truckee. The males appeared to be more nervous and more touchy, flying farther for conflict with passing males than the males of *Ophiogomphus morrisoni nevadensis*.

7. *AESHNA MULTICOLOR* Hagen.

Abundant. One pair caught.

8. *MACROMIA MAGNIFICA* Mc Lachlan.

Several were observed on the river. At 5 o'clock in the afternoon a male and female were seen patrolling the road at the agency. The male was taken.

9. *LIBELLULA PULCHELLA* Drury.

Several seen along the river.

10. *SYMPETRUM CORRUPTUM* (Hagen).

Abundant. This species oviposits in the shallow edge of the river, the male holding the female. She taps the water from one to six times in close succession, then the pair fly 50 to 100 feet farther to the next shallow, this proceeding sometimes covering several hundred feet of shore. The female also oviposits alone, when she takes a much shorter flight, striking the water more frequently. The males were most abundant about the water, but the females were met in the fields or anywhere.

11. *SYMPETRUM PALLIPES* (Hagen).

The least common of the three species of *Sympetrum*.

12. *SYMPETRUM SEMICINCTUM* (Say).

Common along the agency ditch.

PYRAMID LAKE, NEVADA.

Pyramid Lake, at an elevation of 3,880 feet, with the exception of its twin, Winnemucca Lake, is the lowest of the several saline lakes which occur in the Nevada Basin and constitute the remnants of the once great Lake Lehontin. Pyramid Lake is even yet a great lake,

40 miles long and 10 broad. It is saline with a density of 1.0034, or about one-ninth that of sea water. It is a brilliant emerald green body of water, surrounded by rugged brown hills barren of any vegetation except sagebrush and the few desert plants that survive the extreme aridity of this region. The only green vegetation is that of the cottonwoods and alders in the delta of the Truckee River. The only conspicuous life is that of the grotesque pelicans which wade solemnly in single file along its beaches.

It has been shown by R. C. Osburn¹ that Odonata can not live comfortably in a density of sea water much over 1.003. I found the following four species breeding in the lake and the pools back of the beach line.

1. *ENALLAGMA CARUNCULATUM* Morse.

One male was found when I went over my Pyramid Lake material carefully. (In my notes in the Annals of the Entomological Society of America² I mentioned only two species in Pyramid Lake, *Enallagma clausum* and *Sympetrum corruptum*.) This species may breed in the lake in very limited numbers or it may be from the Truckee Delta, which was 1 mile west. This species is the most widely spread of all the western species of *Enallagma* and an alkali pond species, so it might be expected.

2. *ENALLAGMA CLAUSUM* Morse.

This bred in large numbers in the shallow edge of the lake. A species of *Potamogeton* grows sparingly along the shore of the lake, and to this are attached masses of filamentous algae. These masses break loose and are washed along the beach in quantity. In this litter two species of Odonata breed freely, *Enallagma clausum* and *Sympetrum corruptum*. Through the wave action the beach at the edge of the water is built into a low dyke over which storms force high waves that make a series of algae-filled pools from which both species emerge freely. Probably these individuals are washed into these pools from the lake when the pools are formed. On fence posts 50 feet from shore I found exuviae of both species.

Enallagma clausum has habits of alighting on the beach and flying quickly along the surface of the ground which are much like those of an *Argia*. Because of their nervous alertness and this habit of hugging the ground they are very difficult to capture, though they occur in large numbers. Copulation is on the wing or while seated on the beach or on the masses of algae. Emergence is at all hours, as I saw fresh teneral at 3 o'clock in the afternoon. The male holds the female during oviposition while she places the eggs in the masses of algae.

3. *ISCHNURA CERVULA* Selys.

One male was found among my material.

¹ Amer. Nat., vol. 40, 1906, p. 395.

² Ann. Ent. Soc. Amer., vol. 8, 1915, p. 207.

4. SYMPETRUM CORRUPTUM (Hagen).

This species is abundant all over the West, except above 5,000 feet. But here it fairly swarmed, occurring in far greater numbers than I had seen it anywhere else. Its exuviae hung on driftwood along the beach several deep.

HUMBOLDT RIVER, CARLIN, NEVADA.

August 6 to 10 was spent in a hurried trip up the Humboldt River. This strange river rises in the mountains on the east side of Nevada and runs west nearly across the State to flow out onto the Humboldt Flats, where it forms a large shallow lake called Humboldt Sink. Humboldt Sink is surrounded by miles of snow-white alkali flats. I did not get to it. The Humboldt River runs through a region of low mountains barren of vegetation except sagebrush and its usual accompaniments. The river is alkaline in most of its lower course and is strange in that no trees whatever grow along its banks. Instead, there are great stretches of dense thickets of slender willows, called "pin willows" by the cow punchers of the region. As these grow up to the edge of the perpendicular clay banks of the stream, following the course of the stream on foot along the bank for any distance is almost impossible. Humboldt River has the same fauna as the lower Truckee, the only other stream of the Lehontin Basin examined.

The river at Carlin, which was the farthest upstream examined, flowed over continuous gravel beds. In the bottoms were several sloughs from waste irrigating water. I collected here on August 6.

1. LESTES CONGENER Hagen.

Abundant.

2. ARGIA EMMA Kennedy.

Occasional on the river banks.

3. ENALLAGMA CARUNCULATUM Morse.

A few seen on a slough.

4. ISCHNURA CERVULA Selys.

Common about the sloughs.

5. ISCHNURA PERPARVA Selys.

About the sloughs.

6. OPHIOGOMPHUS MORRISONI NEVADENSIS Kennedy.

Several caught on the gravel bars, but collecting made difficult by a large flock of killdeers which flew ahead and disturbed the dragonflies.

7. ERPETOGOMPHUS COMPOSITUS Hagen.

Three males caught.

8. AESHA PALMATA Hagen.

One male taken. Several seen among willow thickets near the sloughs.

9. LIBELLULA FORENSIS Hagen.

Several seen.

10. *LIBELLULA PULCHRELLA* Drury.

More common than the last. About the sloughs.

11. *SYMPETRUM CORRUPTUM* (Hagen).

Common on the gravel bars of the river.

12. *SYMPETRUM RUBICUNDULUM DECISUM* (Hagen).

Occasional in the bottoms.

13. *SYMPETRUM MADIDUM* (Hagen).

Two males taken.

14. *SYMPETRUM PALLIPES* (Hagen).

Common, especially in the shade of the willows.

HUMBOLDT RIVER, GOLCONDA, NEVADA.

Humboldt Valley at this point is about 2 miles wide; its floor is a level alkali flat, thickly grown up to greasewood bushes, except along the banks of the river, where there are dense thickets of "pin willows." The elevation of the valley at this point is 4,391 feet. On both sides are the low barren sage-covered mountains characteristic of the Nevada. Several large, hot springs occur at Golconda, the Chinese laundry with characteristic oriental thrift using one. The largest is west of the hotel, and with its various subordinate springs irrigates an area of several acres. It has built up a mound one-eighth mile in diameter and 8 feet above the surrounding flat. The largest outlet is a pool 20 by 30 feet, too hot for living insects. At one end of this is a scum composed of dead beetles and other aquatic insects cooked to death. The subordinate springs have pools in various parts of this mound, which vary from cold to very hot. It is in the cooler pools, which support aquatic plants, that Odonata are found.

The river at Golconda is about a hundred feet wide and 6 feet deep in the channel. It meanders through the alkali flat with such intricate turns that I walked three hours along its bank and returned across lots to my starting point in 20 minutes. As the flat near the river has many areas of salt grass sod, wherever the river cuts into one of these, it undermines the heavy sod which falls off in great squares. Few gravel bars occur. The water is yellow with alkali mud, and it fairly swarms with carp. I collected here on August 7 and again on August 9.

1. *LESTES CONGENER* Hagen.

Breeding in the warm springs.

2. *LESTES UNGUICULATUS* Hagen.

Several caught around the warm springs. Probably breeding there.

3. *ARGIA EMIMA* Kennedy.

One female was taken on the river. The only one seen.

4. *ENALLAGMA ANNA* Williamson.

One was found among the *Enallagma* caught about the springs.

5. *ENALLAGMA CALVERTI* Morse.

Occasional about the springs.

6. ENALLAGMA CARUNCULATUM Morse.

The most abundant species of *Enallagma*.

7. ENALLAGMA CLAUSUM Morse.

A single male found among those collected about the springs.

8. ISCHNURA CERVULA Selys.

Common about the springs.

9. ISCHNURA PERPARVA Selys.

Common. A male was taken which had the coloration of *Ichnura demorsa* (Hagen).

10. CELAENURA DENTICOLLIS (Burmeister).

About one warm spring this was numerous.

11. OPHIOGOMPHUS MORRISONI NEVADENSIS Kennedy.

A single male was caught on a gravel bar in the river, the only one seen.

12. GOMPHUS INTRICATUS Hagen.

Several individuals were caught on the river (see p. 550).

13. GOMPHUS OLIVACEUS NEVADENSIS Kennedy.

Common on the river (see p. 557).

14. ANAX JUNTUS (Drury).

One male caught in the "*Aeshna* swarm."

15. AESHNA CONSTRICTA Say.

Three females were taken here. These were verified by Dr. E. M. Walker. It is the farthest southwest record for this species. Except *Aeshna multicolor* Hagen, which was also taken around the warm springs, and one of the *constricta*, which was taken in a greasewood thicket, all the *Aeshna* were caught in the space of an hour near the large spring west of the hotel when at 6 p. m. they were flying in a large "*Aeshna* swarm" which was perhaps 200 feet in diameter. Hundreds of *Aeshna* were evidently feeding on some particular swarm of smaller insects and their numbers made the individuals fearless, so they were easily taken. About twenty, altogether, were caught. This was the only "*Aeshna* swarm" I have ever seen. It contained four species and thinned out after an hour's vigorous net work.

16. AESHNA INTERRUPTA INTERNA Walker.

Several males were caught in the *Aeshna* swarm. No *interrupta nevadensis* were taken at this place. They apparently belong to the damper and higher Sierra.

17. AESHNA MULTICOLOR Hagen.

Abundant about the warm springs. This is the abundant species at this point. Several were caught in the *Aeshna* swarm.

18. AESHNA PALMATA Hagen.

Several males were caught in the *Aeshna* swarm.

19. MACROMIA MAGNIFICA Mc Lachlan.

One male was observed on the river.

20. LIBELLULA FORENSIS Hagen.

Common about the springs.

21. *LIBELLULA NODISTICTA* Hagen.

One was caught on a fence back of the hotel. Not seen elsewhere.

22. *LIBELLULA PULCHELLA* Drury.

Common about the springs.

23. *PLATHEMIS SUBORNATA* Hagen.

One male was caught near a spring. This is the first record for this species west of Utah.¹ It was not common at this point.

24. *ERYTHEMIS SIMPLICICOLLIS* (Say).

Common about the pond east of the hotel.

25. *SYMPETRUM CORRUPTUM* (Hagen).

Occasional on the gravel bars in the river.

26. *SYMPETRUM COSTIFERUM* (Hagen).

Occasional about the pond east of the hotel.

27. *SYMPETRUM PALLIPES* (Hagen).

Common in the willow thickets along the river. This species seems always to prefer cool somewhat shaded places.

28. *SYMPETRUM SEMICINCTUM* (Say).

Common in the fields along the river. The males of this species sometimes go to sleep while seated in the sunshine, when they can be picked up by hand.

HUMBOLDT RIVER, WINNEMUCCA, NEVADA.

The Humboldt River at this point is about twice as large as at Golconda and twice as muddy. It has no gravel bars. "Pin willow" thickets made collecting impossible except near the town. Three hours on August 8 were spent here.

1. *LESTES CONGENER* Hagen.

Several seen along a ditch.

2. *ARGIA EMMA* Kennedy.

Several caught along the river.

3. *ENALLAGMA CARUNCULATUM* Morse.

Common along a ditch.

4. *GOMPHUS OLIVACEUS NEVADENSIS* Kennedy.

About 20 were caught in the willow thickets near the slaughter-house (see p. 557).

5. *AESHNA MULTICOLOR* Hagen.

Several seen. A male caught.

6. *MACROMIA MAGNIFICA* Mc Lechlan.

A single male was seen on the river.

7. *SYMPETRUM SEMICINCTUM* (Say).

Common in the willow thickets.

HUMBOLDT RIVER, LOVELOCKS, NEVADA.

At Lovelocks the Humboldt Valley widens out and has been put under irrigation. The river at this point flows through an earth-walled channel 20 to 40 feet deep. As nearly all the water is taken

¹ During August, 1915, I found this species of *Platheimis* abundant in Owens Valley, Inyo County.

out for irrigation, one can wade back and forth across the bottom of the river channel. Otherwise collecting at this point would be very difficult. I collected here on August 10.

1. *ENALLAGMA CARUNCULATUM* Morse.

Common on stagnant ditches.

2. *CELAENURA DENTICOLLIS* (Burmeister).

Occasional on ditches.

3. *ERPETO GOMPHUS COMPOSITUS* Hagen.

Several were caught along the river.

4. *GOMPHUS INTRICATUS* Hagen.

Abundant along the river. Several exuviae found (see p. 570).

5. *GOMPHUS OLIVACEUS NEVADENSIS* Kennedy.

Common along the river (see p. 557).

6. *LIBELLULA COMPOSITA* Hagen.

A single female of this rare species was caught while she was perched on the top of a greasewood bush. This is the only one of this species I have seen alive.¹ G. F. Ferris gave me a second female caught at Provo, Utah. The type was taken on the "Yellowstone." Others have been taken at Salt Lake City. This is the first record west of Utah. Its color fits the description given by Hagen² and also by Ris.³ In life its eyes were creamy white with a pearly luster. It is the only white-eyed dragonfly I have seen. The Provo female had a small nodal spot in each wing.

7. *ERYTHEMIS SIMPLICICOLLIS* (Say).

Common around ditches.

8. *SYMPETRUM COSTIFERUM* (Hagen).

Occasional.

9. *SYMPETRUM SEMICINCTUM* (Say).

Common about ditches.

SAN JOAQUIN VALLEY, CALIFORNIA.

From September 1 to 15, 1914, I made a trip down the San Joaquin River to Bakersfield, thence over the mountains to Los Angeles. This was very late in the odonate season, but some interesting data were obtained. The records obtained around Los Angeles will be reported on in my next paper, which will discuss the Odonata of southern California. The following lists concern the San Joaquin Valley.

Stretched lengthwise for almost 400 miles through the central part of California lies the great interior valley. Its floor, more level than a prairie and in many places from 30 to 50 miles wide, lies just above sea level. Shut off from the cool moist winds of the Pacific by the

¹ During August, 1915, I found *Libellula composita* common in Owens Valley, California.

² U. S. Surv. Terr. Colo. (1873), p. 728, 1873.

³ Collections Selys, fasc. 11, *Libellulinae*, 1910, p. 267.

Coast Ranges it is a hot, dry region. In this interior valley several Mexican species reach their northernmost range.

The northern half of this valley is drained by the Sacramento River, which flows south into San Francisco Bay. The southern half is drained by the San Joaquin River, which flows north, emptying into the bay near the mouth of the Sacramento.

This southern half, usually called the San Joaquin Valley, may be divided into two quite different regions: The main valley, which is dry and sandy with no trees except along the river, and the delta at the north end, in which is located the city of Stockton.

STOCKTON, SAN JOAQUIN COUNTY, CALIFORNIA.

Stockton lies out in the level San Joaquin Valley, but several miles back from the river on ground above river floods. This region, which is roughly coextensive with San Joaquin County, is the delta of the San Joaquin River. It is a hot, level country which has been reclaimed by dredging the numerous winding channels of this river and by the building of great dikes along those channels which confine the early summer flood of snow water. There are said to be over 200 miles of these winding lateral channels of the San Joaquin River, which are navigable to the odd stern-wheel steamers that carry the produce of this fertile delta region down to San Francisco. These winding, placid streams, brown with mud, are everywhere fringed with green weeping willows, whose drooping branches give to the region the appearance of a languor such as the great humidity and heat produce in the observer. As much of this reclaimed land is actually below tide, this region has been aptly termed the "Holland of America."

The collecting was done on Mormon Slough, in the heart of Stockton, and along the river dikes west of the city.

1. *ENALLAGMA CARUNCULATUM* Morse.

Common on Mormon Slough.

2. *ISCHNURA CERVULA* Selys.

Common on Mormon Slough.

3. *GOMPHUS OLIVACEUS* Selys.

One female was caught on the river dike. This was the only one seen.

4. *ANAX JUNIUS* (Drury).

Occasional on the sloughs.

5. *AESHNA MULTICOLOR* Hagen.

Very abundant on the sloughs.

6. *AESHNA PALMATA* Hagen.

Two females identified by Dr. E. M. Walker as *palmata* were caught on the dyke along Calaveras Creek.

7. *MACROMIA MAGNIFICA* Mc Leckian.

One female was caught on the dyke along Calaveras Creek. She was old, with frayed wings.

8. *LIBELLULA PULCHELLA* Drury.

Not common.

9. *LIBELLULA SATURATA* Uhler.

Not common.

10. *PLATHEMIS LYDIA* (Drury).

One male caught.

11. *ERYTHEMIS SIMPLICICOLLIS* (Say).

Saw one female. Not common.

12. *SYMPETRUM CORRUPTUM* (Hagen).

Common on the sloughs.

13. *SYMPETRUM ILLOTUM* (Hagen).

Scarce.

14. *SYMPETRUM SEMICINCTUM* (Say).

Scarce.

FRESNO, FRESNO COUNTY, CALIFORNIA.

Fresno, surrounded by its vineyards, lies near the great bend of the San Joaquin. East of Fresno the river comes down from the Sierras a swift, snow-fed mountain stream, but turning abruptly it flows away to San Francisco Bay in the north. In this lower, level portion of its course through the hot, dry San Joaquin Valley it is almost the opposite of a mountain stream. It meanders sluggishly over a bed of shifting white sand. Its waters become turbid and warm.

Collecting at Fresno was done at Fresno Beach, a city recreation park on the banks of the river, and at Friant, a few miles from Fresno, where the San Joaquin emerges from its Sierra canyon.

FRIANT, FRESNO COUNTY, CALIFORNIA.

The following list was taken September 4, 1914, at Friant, which is a village on the San Joaquin where the latter emerges from the great canyon through which it descends from the high Sierra. Here for a few miles before it reaches the level valley floor it is a swift stream 300 feet wide, from 1 to 5 feet deep, flowing over a bed of gravel.

1. *ARGIA EMMA* Kennedy.

Several seen.

2. *ERPETOGRAPHUS COMPOSITUS* Hagen.

This was very abundant and will be discussed fully in my next paper.

3. *ANAX JUNIUS* (Drury).

One or two observed.

4. *AESHNA MULTICOLOR* Hagen.

Several *Aeshna*, probably this, were observed.

5. *LIBELLULA SATURATA* Uhler.

Observed.

6. *SYMPETRUM CORRUPTUM* (Hagen).

Common as usual.

7. *BRECHMORHOGA MENDAX* (Hagen).

This graceful species was present here. In the course of the day's collecting I saw not less than a dozen individuals. These usually had short beats in the shade of the occasional large willow trees that grew on the gravel beaches. Several were caught.

8. *TRAMEA LACERATA* Hagen.

Several were caught among the willows in the mouth of the canyon.

FRESNO BEACH, FRESNO COUNTY, CALIFORNIA.

On September 5, 1914, the species in the following list were taken at Fresno Beach, a pleasure park 12 miles from Fresno. Here, excepting *Hetaerina americana* (Fabricius) and *Sympetrum corruptum* (Hagen), which were caught along the sandy banks of the river, the entire list was taken around a back-water slough near the river. This swarmed with pond species, though the water was thick with algae and almost entirely covered with duckweed.

1. *HETAERINA AMERICANA* (Fabricius).

Common along the willows overhanging the river.

2. *ENALLAGMA CARUNCULATUM* Morse.

Common about the slough.

3. *TELEBASIS SALVA* (Hagen).

This small bright red species was very abundant over the edges of the slough. They flew about quite commonly in pairs. The female oviposited while the male held her.

4. *ISCHNURA CERVULA* Selys.

Common.

5. *ISCHNURA PERPARVA* Selys.

Common.

6. *CELAENURA DENTICOLLIS* (Burmeister).

Common and associated with *Telebasis*.

7. *ANAX JUNIUS* (Drury).

This species was abundant and its habits more fully observed than I had been able to observe them elsewhere. The male seized the female on the wing and retained his hold on her head while she oviposited. The pair would alight on the floating masses of algae. The female would bend her abdomen down and forward making from three to ten thrusts in the loose mass of algae whereupon the pair would fly to another place. Apparently the eggs were merely extruded among the filaments of the algae.

8. *AESHNA MULTICOLOR* Hagen.

Common as usual.

9. *LIBELLULA SATURATA* Uhler.

Common.

10. *PLATHEMIS LYDIA* (Drury).

Several seen.

11. *ERYTHEMIS SIMPLICICOLLIS* (Say).

Common. This was flying about the edges of the pond in company with *Pachydiplax*. It is bolder in its flight than *Pachydiplax*.

12. *SYMPETRUM CORRUPTUM* (Hagen).

Common.

13. *SYMPETRUM ILLIOTUM* (Hagen).

Several seen.

14. *PACHYDIPLAX LONGIPENNIS* (Burmeister).

This was more common than I have seen it elsewhere in the West. It is a shore-line species of ponds, seldom straying from the edge of the water. Its habits are similar to those of *Erythemis*, with which it is always associated. However, it usually rests *Sympetrum*-like on the tips of snags and sedges at distances of one to 5 feet above the water while *Erythemis* alights most often as close to the surface as possible. The exuviae of *Pachydiplax* were common on logs and the bases of trees where the nymphs had crawled up from 1 to 3 feet above the surface of the water.

15. *PANTALA HYMENAEA* (Say).

Two individuals were caught flying with *Tramea* over a pasture near the pond. Not common.

16. *TRAMEA LACERATA* Hagen.

Tramea was more abundant here than I have ever seen it elsewhere. It was an interesting species because of its great dexterity on the wing. In the early morning *Tramea* was found flying high and wide, each on a short beat which was frequently changed. After 10 or 11 o'clock, when the heat of midday had increased their activity, they were found over the surface of the pond ovipositing. I saw an occasional female ovipositing unaccompanied by a male but usually every female had a very attentive male companion. As *Tramea* seldom alights, the male would catch the female on the wing. While holding her the pair would fly about over the surface of the pond, stopping occasionally to oviposit over the surface where this was free from the scum of algae and duckweed. The pair would poise about 6 inches above the surface of the water. The male would release the female and remain poised while she would drop to the surface, and with a short swing, tap the surface just once, when she would rise to the male who would instantly grasp her thorax with his claspers without first seizing her with his feet. This quick release and the almost immediate reclasping of the female was one of the most dexterous performances I had ever observed in dragonflies.

Exuviae were common on the stumps and logs lying about the edges of the slough.

REEDLEY, FRESNO COUNTY, CALIFORNIA.

I spent September 6 collecting on Kings River near Reedley. Nothing was taken except *Aeshna multicolor* Hagen and *Macromia magnifica* McLachlan. This is interesting in being the farthest south record for *Macromia magnifica* in California.

BAKERSFIELD, KERN COUNTY, CALIFORNIA.

Bakersfield lies at the southern or head end of the San Joaquin Valley. It is on the Kern River, which is a tributary of the San Joaquin but only in exceptionally wet seasons. At other times the Kern is drained for irrigation shortly after reaching the level valley floor. The collecting was done in the bottoms near the oil field. The species are largely slough forms.

1. HETAERINA AMERICANA (Fabricius).

In the willows fringing the river.

2. ENALLAGMA CARUNCULATUM Morse.

Common.

3. ENALLAGMA CYATHIGERUM (Charpentier).

Several caught.

4. ISCHNURA CERVULA Selys.

Common along the irrigation canal.

5. CELAENURA DENTICOLLIS (Burmeister).

Common along a slough.

6. ANAX JUNIUS (Drury).

This species was very abundant, breeding in the sloughs. It was interesting to observe it about the ponds of black crude oil. Several individuals were caught that had been crippled by brushing their wings in the gummy oil. One female was found with the posterior segments of the abdomen soiled with oil. It was evident that they frequently mistook the glassy surface of these oil ponds for water.

Across the river, south from the oil field, was an abandoned well beside which was a small pond of fully hardened oil left when the well was deserted. This in portions was almost a continuous mass of dead *Anax* and water beetles. These were entirely covered with the oil so that I did not at first recognize what it was that caused the odd roughness of the surface as I walked over it. Hundreds and perhaps several thousand had been caught in this small pond. It would seem that *Anax* has no very keen sense of smell or these very odoriferous death traps would be avoided.

MODESTO, MARIPOSA COUNTY, CALIFORNIA.

The following list of species was taken by Mr. G. F. Ferris, of Stanford University, in the region of the San Joaquin Valley around Modesto. The elevation is less than 1,000 feet. These were caught during May and June, 1914. The specific localities are Pleasant Valley, Modesto, and Coulterville.

1. *LESTES CONGENER* Hagen.
One female, Pleasant Valley.
2. *ARGIA AGRIOIDES* Calvert.
One male, Pleasant Valley.
3. *HYPONEURA LUGENS* Hagen.
Three males and three females from Pleasant Valley.
4. *ARGIA VIVIDA* Hagen.
Six females, Pleasant Valley; one female, Bean Creek, at Coulterville.
5. *ENALLAGMA CYATHIGERUM* (Charpentier).
Pleasant Valley and Bean Creek, Coulterville.
6. *AMPHIAGRION SAUCIUM ABBREVIATUM* Setys.
Two males and a female from Bean Creek, Coulterville. This is the lowest altitude in California at which this species has been taken.
7. *ISCHNURA CERVULA* Setys.
A male and female from Modesto.
8. *ISCHNURA PERPARVA* Setys.
Three males and four females from Coulterville.
9. *PROGOMPHUS BOREALIS* Mc Lechian.
One male, Pleasant Valley.
10. *GOMPHUS OLIVACEUS* Setys.
A male from Bean Creek, Coulterville. This is the farthest south record of this species in the San Joaquin Valley.
11. *OCTOGOMPHUS SPECULARIS* (Hagen).
Pleasant Valley and Coulterville.
12. *AESHNA MULTICOLOR* Hagen.
Pleasant Valley.
13. *LIBELLULA FORENSIS* Hagen.
One female, Coulterville.
14. *LIBELLULA NODISTICTA* Hagen.
A male and female, Coulterville.
15. *LIBELLULA FULCHELLA* Drury.
One female, Pleasant Valley.
16. *LIBELLULA SATURATA* Uhler.
A male and female, Pleasant Valley.
17. *PLATHEMIS LYDIA* (Drury).
Modesto and Coulterville.
18. *SYMPETRUM CORRUPTUM* (Hagen).
Two males and three females, Coulterville.
19. *SYMPETRUM ILLIOTUM* (Hagen).
Modesto and Pleasant Valley.
20. *SYMPETRUM PALLIPES* (Hagen).
Pleasant Valley, one male.
21. *PACHYDIPLAX LONGIPENNIS* (Burmeister).
A male and female from Modesto.

THREE RIVERS, TULARE COUNTY.

The town of Three Rivers lies on the Kaweah River in the southern end of the San Joaquin Valley. The elevation is from 500 to 800 feet. The specimens listed below were collected during July and August, 1914 and 1915, by Mr. and Mrs. L. R. Reynolds, of San Francisco, and by Dr. J. C. Bradley on July 12-14, 1907. The latter are in the collection of Cornell University.

1. *ARGIA AGRIOIDES* Calvert.

Males and females by Mr. and Mrs. L. R. Reynolds. One male and two females by Dr. J. C. Bradley.

2. *ARGIA EMMA* Kennedy.

Collected by Mr. and Mrs. L. R. Reynolds.

3. *ARGIA VIVIDA* Hagen.

Several, Mr. and Mrs. L. R. Reynolds; two males and one female by Dr. J. C. Bradley.

4. *ENALLAGMA CARUNCULATUM* Morse.

Several by Mr. and Mrs. L. R. Reynolds.

5. *TELERASIS SALVA* (Hagen).

Several by Mr. and Mrs. L. R. Reynolds; male and female by Dr. J. C. Bradley.

6. *ISCHNURA PERPARVA* Selys.

Collected by Mr. and Mrs. L. R. Reynolds.

7. *CELAENURA DENTICOLLIS* (Barnmeister).

Collected by Mr. and Mrs. L. R. Reynolds.

8. *CORDULEGASTER DORSALIS* Hagen.

One female in the Cornell collection taken by Dr. J. C. Bradley.

9. *OPHIOGOMPHUS BISON* Selys.

These are the types of Miss Butler's *Ophiogomphus sequoiarum*. They are in the Cornell collection, having been taken by Dr. J. C. Bradley.

10. *LIBELLULA SATURATA* Uhler.

A male and female collected by Mr. and Mrs. L. R. Reynolds; four males collected by Dr. J. C. Bradley.

11. *PLATHEMIS LYDIA* (Drury).

Collected by Mr. and Mrs. L. R. Reynolds.

12. *SYMPETRUM CORRUPTUM* (Hagen).

Taken by Mr. and Mrs. L. R. Reynolds.

EXETER, TULARE COUNTY.

The following species are in the Cornell collection, having been taken by Dr. J. C. Bradley at Exeter, in the hot, southern end of the San Joaquin Valley.

1. *CELAENURA DENTICOLLIS* (Barnmeister).

2. *ERYTHEMIS SIMPLICICOLLIS* (Say).

3. *SYMPETRUM CORRUPTUM* (Hagen).

4. *PACHYDIPLAX LONGIPENNIS* (Barnmeister).

5. *TRAMEA LACERATA* Hagen.

SOUTHERN SIERRA NEVADA MOUNTAINS.

The following list is compiled from sources as follows:

Records on specimens in the collection of the California Academy of Science.

Records on specimens in Mr. Fordyce Grinnell's collection in the Southwest Museum of Los Angeles.

From a collection sent me by Mr. and Mrs. L. R. Reynolds of San Francisco, who had collected in the region of Sequoia National Park.

From a collection sent me by Mr. G. F. Ferris of the entomological department of Stanford University, who had collected in the region of Yosemite National Park.

From specimens collected by Dr. J. C. Bradley in the Mount Whitney region during July and August, 1915, and now deposited in the Cornell collection.

From specimens in the Cornell collection collected by Dr. J. H. Comstock in Tuolumne County and the Sequoia National Park, July 17-24, 1907.

The species are Canadian and the list agrees with those I collected at altitudes of from 5,000 to 7,000 feet in the region of Lakes Donner and Tahoe (see pp. 611-616 of this paper). The list is also repeated in the series of Canadian species I caught at 4,000 feet elevation near Bend, Oregon,¹ and agrees with the list² collected by R. C. Osburn.

As stated at the beginning of these locality lists, the eastern side of the State of California for nearly its entire length is occupied by the great upland of the Sierra Nevada Mountains. This rises gradually through a distance of 30 to 50 miles from the Sacramento and San Joaquin Valleys on its west side until an altitude of 7,000 to 10,000 feet is reached near the Nevada boundary. Above this tower the great peaks of Lyell and Whitney with their lesser but numerous companions. After reaching this great altitude along the eastern border of the State the Sierra drops suddenly by the greatest escarp in North America to the comparatively low elevation of 3,000 feet. Nearly the entire west slope from 2,000 feet up to 8,000 feet is covered with coniferous timber, which is usually sparse.

This great Sierra apparently forms a barrier to several Pacific coast species such as *Lestes stultus* Hagen, *Zoniagrion exclamationis* (Selys), *Ischnura erratica* Calvert, *Cordulegaster dorsalis* Hagen, *Ophiogomphus bison* Selys, *Octogomphus specularis* (Hagen), and *Aeshna walkeri* Kennedy. To a less extent it shuts interior forms away from the coast, such perhaps as *Enallagma clausum* Morse, *Libellula composita* Hagen, and *Plathemis subornata* Hagen.

The following list includes the majority of those interesting northern species which are able to maintain existence as far south as

¹ Proc. U. S. Nat. Mus., vol. 49, July, 1915, pp. 338-337.

² Ent. News, vol. 16, 1905, pp. 184-190.

central California by living in the swamps and lakes of this cool elevated region.

1. *LESTES CONGENER* Hagen.

One male, 2 females, Sugar Pine, Tuolumne County, 5,000 feet, Dr. J. H. Comstock.

2. *LESTES DISJUNCTUS* Setys.

Walker Lake, Mono County, 7,700 feet, Ferris. Male and female, Harden Lake, Tuolumne County, 7,575 feet, Dr. J. H. Comstock.

3. *LESTES UNCATUS* Kirby.

Yosemite Valley, 4,000 feet, Devils Post Pile, Yosemite Park, 8,000 feet, Ferris. Tuolumne Meadows, Tuolumne County, 8,500 feet, Reynolds, Ferris.

4. *ARGIA VIVIDA* Hagen.

Four males and one female. Giant Forest, Marble Fork, Kings River Trail, Sequoia National Park, 6,500 to 7,000 feet, Dr. J. C. Bradley. Sugar Pine, Tuolumne County, 5,000 feet, Dr. J. H. Comstock. Probably living in springs at this high altitude.¹

5. *ENALLAGMA CALVERTI* Morse.

Walker Lake, Mono County, 7,700 feet, Ferris.

6. *ENALLAGMA CYATHIGERUM* (Charpentier).

Gem Lake, Mono County, 9,000 feet, Ferris. Tuolumne Meadows, Yosemite National Park, 8,600 feet, Ferris. Twin Lakes, Sequoia National Park, 10,550 feet, Reynolds. Crabtree Meadows, near Mount Whitney, 10,550 feet, two female *Enallagma*, probably this species, Dr. J. C. Bradley. One male, Harden Lake, Tuolumne County, 7,575 feet, Dr. J. H. Comstock. Cathedral Lake, Tuolumne County, 9,500 feet, Dr. J. H. Comstock.

7. *AMPIAGRION SAUCIUM ABBREVIATUM* Setys.

South Fork of Kings River, 6,300 feet, California Academy of Science, Tenaya Canyon. Yosemite National Park, 7,500 feet, Ferris. Ranger, Sequoia National Park, 8,250 feet, Reynolds.

8. *OPHIOGOMPHUS MORRISONI* Setys.

One female of typical *morrisoni*, Mount Whitney, Siberian Outpost, 9,000 to 10,000 feet, Dr. J. C. Bradley, July 31, 1915.

9. *OPHIOGOMPHUS MORRISONI NEVADENSIS* Kennedy.

Pumice Valley, Mono County, 6,800 feet, Ferris. Two females of *morrisoni* were sent in by Mr. Ferris. These were of the pale form *nevadensis*, though not as pale as females from Owens Valley and central Nevada. If this is *nevadensis* at this altitude the two forms probably intergrade.

10. *ANAX JUNIUS* (Drury).

Male and female, Sugar Pine, Tuolumne County, 5,000 feet, Dr. J. H. Comstock.

¹ Ann. Ent. Soc. Amer., vol. 8, 1915, p. 293.

11. AESHNA INTERRUPTA NEVADENSIS Walker.

Walker Lake, Mono County, 7,700 feet, Ferris. Elizabeth Lake, Yosemite National Park, 9,000 feet, Reynolds. Four males and one female, Harden Lake, Tuolumne County, 7,575 feet, Dr. J. H. Comstock.

12. AESHNA PALMATA Hagen.

One male, Sugar Pine, Tuolumne County, 5,000 feet, Dr. J. C. Bradley.

13. CORDULIA SHURTLEFTI Scudder.

Tuolumne Meadows, Yosemite National Park, 8,600 feet, Ferris. Dog Lake, Yosemite National Park, 9,000 feet, Reynolds.

14. SOMATOCHLORA SEMICIRCULARIS (Selys).

Cahoon Meadows, Giant Forest, 7,000 to 8,000 feet, August 15, 1915, Dr. J. C. Bradley.

15. LIBELLULA PULCHRELLA Drury.

Yosemite Valley, 4,000 feet, Ferris. This species is an intermediate species. At extreme elevations *quadrifasciata* is the only *Libellula*.

16. LIBELLULA QUADRIFASCIATA Linnaeus.

Yosemite Valley, 4,000 feet, Ferris. This is almost as low as this species comes in middle California. Tuolumne Meadows, Yosemite National Park, 8,600 feet; Walker Lake, Mono County, 7,700 feet, Ferris. Harden Lake, Tuolumne County, 7,575 feet, Dr. J. H. Comstock.

17. LIBELLULA SATURATA Uhler.

Male and female, Giant Forest, Sequoia National Park, 6,500 feet, Dr. J. H. Comstock. This is the highest record for this species. The record appears to be correct. It is distinctly a hot valley species. See *Pachydiplax*, p. 635.

18. PLATHEMIS LYDIA (Drury).

One male, Giant Forest, Sequoia National Park, 6,500 feet, Dr. J. C. Bradley, July 17, 1907. The upper limit of this species. See *Pachydiplax*, p. 635.

19. SYMPETRUM CORRUPTUM (Hagen).

Fresno County, 10,000 feet, California Academy. Mount Hutchings Ridge, 10,450 feet, Grinnell. Mono Lake, Mono County, California, Ferris. Crabtree Meadows, near Mount Whitney, 10,550 feet, Dr. J. C. Bradley. One female, Sugar Pine, Tuolumne County, 5,000 feet, Dr. J. H. Comstock. Most abundant from sea level up to 5,000 feet.¹

20. SYMPETRUM RUBICUNDULUM DECISUM (Hagen).

Kings River Canyon, 5,000 feet, California Academy. Kern River, 6,000 to 7,000 feet, Dr. J. C. Bradley.

¹ Ann. Ent. Soc. Amer., vol. 8, 1915, p. 300.

21. *SYMPETRUM PALLIPES* (Hagen).

Kings River Canyon, 5,000 feet, California Academy. One female, Giant Forest, Sequoia National Park, 6,500 to 7,100 feet, Dr. J. H. Comstock. One female, Sugar Pine, Tuolumne County, 5,000 feet, Dr. J. H. Comstock.

22. *SYMPETRUM SCOTICUM* (Domevan).

Walker Lake, Mono County, 7,700 feet, Ferris.

23. *SYMPETRUM SEMICINCTUM* (Say).

Yosemite Valley, August 17, 1915, Dr. J. C. Bradley. No altitude record on this specimen. It probably does not go often above 3,000 feet. One female, Giant Forest, Sequoia National Park, 6,500 to 7,100 feet, Dr. J. H. Comstock.

24. *PACHYDIPLAX LONGIPENNIS* (Barnmeister).

One female, Giant Forest, Sequoia National Park, 6,500 to 7,100 feet, Dr. J. H. Comstock. This is the highest record for this species. The record appears correct though this is a species of the low hot valleys. This species, *Libellula satarata* and *Plathemis lydia* are in the Cornell collection, with labels indicating that all three were taken by Dr. J. H. Comstock, July 17, 1907, at an elevation of 6,500 feet. As these are the species most out of place in this list it is possible an error has been made in labeling. I am inclined to doubt their occurrence at this elevation.

25. *LEUCORRHINIA GLACIALIS* Hagen.

Tuolumne Meadows, Yosemite National Park, 8,600 feet, Ferris, Reynolds. Dog Lake, Yosemite National Park, 9,000 feet, Reynolds. Tenaya Canyon, Yosemite National Park, 7,500 feet, Ferris.

26. *LEUCORRHINIA HUDSONICA* (Setys).

Tenaya Canyon, Yosemite National Park, 7,500 feet, Ferris. This is the first California record for this species.

DESCRIPTIONS OF NEW WEST AMERICAN MARINE MOLLUSKS AND NOTES ON PREVIOUSLY DESCRIBED FORMS.

By PAUL BARTSCH,

Curator, Division of Marine Invertebrates, United States National Museum.

The present paper describes and figures new species of West American mollusks belonging to groups which I have previously monographed. It represents material that has come to hand since the monographs were issued. By far the larger portion of the specimens were discovered by the U. S. Bureau of Fisheries steamer *Albatross*, but many were contributed by private West American collectors, whose zeal and efforts continue to materially increase our knowledge of marine life from year to year. In addition to the descriptions of new forms, references to species (chiefly fossil) described by other authors since the monographs were published have been added, and wherever new information on nuclear characters was available it is stated.

I had hoped to be able to present with this a new classification of the Rissoidae, but the slowness attending the acquiring of certain material necessary to a complete understanding of the group has decided me not to withhold the manuscript longer, but to publish the data pertaining to members of that family under the old familiar designation, reserving the necessary changes for the final revision.

I wish to express my thanks to all the students who have contributed material to this study, acknowledgment for which is made under the various species. Credit is due to the photographic division of the United States National Museum for the splendid enlarged photographs of the species described, and to Mrs. E. B. Decker for the careful and painstaking work of perfecting these illustrations by retouching.

PYRAMIDELLIDA (LONGCHAEUS) COOPERI Anderson and Martin.

Plate 42, fig. 3.

Pyramidella cooperi ANDERSON and MARTIN, Proc. Cal. Acad. Sci., ser. 4, vol. 4, 1914, p. 66, pl. 7, figs. 18a 18b.

Shell elongate conic, stout, grayish white. All the early whorls decollated, the three remaining strongly channeled at the summit, flattened between the summit and the peripheral sulcus, angulated

posterior to the sulcus. The space between the peripheral angle and the channeled summit forms a decided groove that separates the whorls. Base short, well rounded. The entire surface of the shell is marked by fine incremental lines and well-marked spiral striations. Aperture moderately large, oval; posterior angle acute; outer lip evenly curved; inner lip strong, straight, revolute, provided with three folds, of which the posterior is very strong, lamellar and parallelly disposed to the peripheral sulcus; the other two folds are less strong and much more oblique.

The specimen described and figured, Cat. No. 194405, U.S.N.M., was collected by Mr. George H. Eldridge in the lower Miocene bluffs of Kern River, 1 mile below the power developing station, on the north side of the river at Bakersfield, California; it consists of the last three whorls, and measures—length 6 mm., diameter 3.6 mm.

PYRAMIDELLA (LONGCHAEUS?) PACKI Dickerson.

Odostomia packi DICKERSON, Bull. Dept. Geol. Univ. Cal., vol. 9, No. 17, 1916, p. 498, pl. 37, fig. 2.

The type, an incomplete specimen of 12 whorls, measures—length 10 mm., diameter 3.5 mm. It was collected in the Eocene, Tejon formation, at University of California locality 2226, Rose Canyon, San Diego County, California.

Of this the author states that the inner lip is marked by two plaits "which is characteristic of this genus." *Odostomia* never has more than one plait. The figure shows a *Pyramidella* with basal portion of the aperture lost, which is probably responsible for the absence of the third fold characterizing the subgenus *Longchaeus*, to which I believe the shell belongs.

PYRAMIDELLA (PHARCIDELLA) MAGDALENENSIS, new species.

Plate 42, fig. 1.

Shell elongate conic, very pale horn yellow; nuclear whorls two, well rounded, forming a depressed helicoid spire, the axis of which is at right angles to that of the succeeding turns, in the first of which it is about one-third immersed. Post-nuclear whorls flattened, narrowly shouldered at the summit with a deep spiral groove at the periphery which shows in the suture of all the turns and gives this the appearance of being deeply channeled. Summit of whorls strongly crenulated, the weak depressions on the sides of the crenulation passing down the sides of whorls for a short distance below the summit; the rest of the surface being marked by fine lines of growth and exceedingly fine spiral striations. The deep peripheral sulcus is crossed by slender axial riblets, which are more slender and more numerous

than the crenulations at the summit of the whorls. Base moderately long, well rounded, provided with a strong fasciole at the anterior end and marked by rather strong incremental lines and very fine spiral striations. Aperture oval, posterior angle acute, outer lip thin, showing four denticles within, of which the median two are the strongest; inner lip thick, almost straight, provided with three folds, of which the first is lamellar and almost transversely disposed; it covers the posterior portion of the basal fasciole; the other two folds are much weaker and much more obliquely placed and extend to the anterior portion of the columella; parietal wall glazed with a thin callus.

The type, Cat. No. 268628, U.S.N.M., was dredged by the U. S. Bureau of Fisheries steamer *Albatross* at station 5628, off Redondo Point, Magdalena Bay, Lower California, in $13\frac{1}{2}$ fathoms, on broken shell bottom. It has 9 postnuclear whorls and measures—length, 5.8 mm.; diameter, 2.1 mm.

This species is nearest related to *Pyramidella* (*Longchaeus*) *mazatlanica* Dall and Bartsch, but can readily be distinguished from it by the fact that the whorls are not overhanging.

EULIMELLA GABBIANA Anderson and Martin.

Eulimella gabbiana ANDERSON and MARTIN, Proc. Cal. Acad. Sci., ser. 4, vol. 4, 1914, p. 68, pl. 7, fig. 20.

This is a typical *Melanella* (*Eulimella*) and does not belong to the Pyramidellidae, but to the related family, Melanellidae. The name will therefore have to be changed to *Melanella gabbiana* Anderson and Martin. The type No. 143 California Academy of Sciences comes from the Lower Miocene, in the bottom of a small canyon about $1\frac{1}{4}$ miles due north of Barker's ranch house, Kern River, Kern County, California.

PYRAMIDELLA (SYRNOLA) OCHSNERI Anderson and Martin.

Eulimella ochsneri ANDERSON and MARTIN, Proc. Cal. Acad. Sci., vol. 4, 1914, p. 66, pl. 7, figs. 23a and 23b.

Anderson and Martin described this species which they collected in the Lower Miocene in the bottom of a small canyon about $1\frac{1}{4}$ miles due north of Barker's ranch house, Kern County, California, locality 64. They give a rather incomplete description and state that the type, which has a broken apex, is 8 mm. long and 3 mm. in diameter.

From the brief description and the figure I am inclined to believe that it is not a *Eulimella*, but belongs to the subgenus *Syrnola*. A comparative statement in the same publication (p. 67) under *Eulimella dilleri* strengthens this belief. The type, No. 138, and cotype, No. 139, are in the California Academy of Sciences.

PYRAMIDELLA (SYRNOLA) DILLEHI Anderson and Martin.

Eulimella dilleri ANDERSON and MARTIN, Proc. Cal. Acad. Sci., vol. 4, 1914, p. 67, pl. 7, fig. 24.

Anderson and Martin found this species in the sea cliff (Miocene), one-quarter mile north of the lighthouse at Cape Foulweather, 4 miles north of Yaquina Bay, locality 37. The type, No. 140, California Academy of Sciences, consists of the last eight whorls and measures 9.5 mm. long and 3.5 mm. wide.

TURBONILLA (STRIOTURBONILLA) CANADENSIS, new species.

Plate 44, fig. 11.

Shell elongate conic, slender, yellowish white. Nuclear whorls small, two and one-half, depressed helicoid, having their axis at right angles to that of the succeeding turns, in the first of which they are about one-fourth immersed. Postnuclear whorls almost flattened, rather high between the sutures, appressed at the summit, marked by quite regular, slightly curved, protractive, axial ribs, of which 14 occur upon the first, 16 upon the second and third, 18 upon the fourth to seventh, 20 upon the eighth, and 22 upon the ninth and the penultimate turn. Intercoastal spaces not quite as wide as the ribs, deeply impressed, terminating at the periphery, which is decidedly angulated. There is a smooth space between the periphery and the succeeding whorl, which falls at some little distance anterior to the periphery of the preceding turn. This gives the whorls a somewhat overhanging appearance. Suture well constricted. Base short, well rounded, entire surface marked by microscopic striations. Aperture subquadrate, posterior angle obtuse; outer lip thin; inner lip slightly curved and somewhat revolute.

The type, Cat. No. 273964, U.S.N.M., was collected by G. Willett, at Forrester Island, Alaska. It is a complete specimen of 11 post-nuclear whorls, and measures—length, 6.3 mm.; diameter, 1.5 mm. Two additional specimens of this species are in Mr. Willett's collection.

TURBONILLA (STRIOTURBONILLA) MONTEZUMA, new species.

Plate 44, fig. 1.

Shell broadly elongate conic, yellowish-white, nuclear whorls two and one-fourth, well rounded, forming a very depressed helicoid spire, having its axis at a right angle to that of the succeeding turns in the first of which it is about one-fourth immersed. Postnuclear whorls well rounded, appressed at the summit, ornamented with very strong, narrow, well rounded, slightly protractive axial ribs of which 18 occur upon the first, 16 upon the second, 14 upon the third to

seventh, and 18 upon the penultimate turn. These ribs become somewhat enfeebled and slightly expanded toward the summit. Intercostal spaces about $3\frac{1}{2}$ times as wide as the ribs marked by a double series of incised pits, of which one is midway between the summit and the periphery while the other is at the periphery. The space between the summit and the median pit is marked by 13 slender incised striations of varying strength, while that between the median and peripheral pit is crossed by 9 incised lines. Suture moderately constricted. Periphery of the last whorl angulated, marking the termination of the axial ribs and intercostal spaces. Base very short, well rounded, marked by 14 subequal and subequally spaced feebly incised wavy spiral striations and slender incremental lines. Aperture very short, decidedly subquadrate, the angles at the junction of the outer and basal lip and the basal and inner lips being almost right angles; posterior angle obtuse; outer lip thin, showing the external sculpture within; inner lip very slightly oblique, and slightly revolute; parietal wall glazed by a thin callus.

The type, Cat. No. 268232 U.S.N.M., was dredged by the U. S. Bureau of Fisheries steamer *Albatross* at station 5678, off Redondo Point, Magdalena Bay, Lower California, in $13\frac{1}{2}$ fathoms, on broken shell bottom. It has 9 postnuclear whorls and measures—length, 4.7 mm.; diameter, 1.5 mm.

TURBONILLA (STRIOTURBONILLA) BARKLEYENSIS, new species.

Plate 42, fig. 8; plate 44, fig. 9.

Shell large, slender, elongate conic, bluish white. Nuclear whorls small, a little more than two and a quarter, depressed helicoid, having their axis at right angles to that of the succeeding turn, in the first of which they are slightly immersed. Postnuclear whorls well rounded, appressed at the summit, marked by slender, curved, moderately regular, slightly protractive, axial ribs, of which 16 occur upon the first to fifth, 18 upon the sixth, 22 upon the seventh and eighth, 24 upon the ninth and tenth, and 26 upon the penultimate turn. Intercostal spaces moderately impressed, terminating a little posterior to the periphery of the whorls. The summit of the succeeding turns falls a little anterior to the termination of the intercostal pits and leaves a smooth band in the suture. Suture moderately constricted. Periphery of the last whorl obtusely angulated. Base moderately long, weakly rounded. The entire surface of the shell is marked by microscopic striations. Aperture large, broad, subquadrate, somewhat effuse at the junction of the basal and the outer lip, posterior angle obtuse; outer lip very thin, showing the external sculpture within; inner lip decidedly oblique, slightly curved and somewhat revolute; parietal wall covered by a thin callus.

The type and 25 specimens of this species were collected by the Geological Survey of Canada, at low tide to deep water, in Barclay Sound, Vancouver Island. Fourteen of these are in the collection of the National Museum, the others are in the Geological Survey of Canada collection.

The type, Cat. No. 211568 U.S.N.M., has lost the nucleus and a part of the first postnuclear turn, the 12 turns remaining measure—length, 9.2 mm.; diameter, 2 mm. The nuclear characters were described from another specimen, bearing the same entry number.

This species was reported in former publications under the name of *Turbonilla* (*Strioturbonilla*) *serrae* Dall and Bartsch, from which it is readily distinguished by its appressed whorls, the summits of *Turbonilla* (*Strioturbonilla*) *serrae* being decidedly shouldered.

TURBONILLA (STRIOTURBONILLA) SANTAMARIANA, new species.

Plate 44, fig. 2.

Shell slender, regularly elongate conic, milk white. Nuclear whorls two and one half, large, well rounded, forming a decidedly elevated spire, the axis of which is at right angles to that of the succeeding turns, in the first of which it is about one-fifth immersed. Postnuclear whorls very high between the sutures, feebly shouldered at the summit, marked by very regular, almost straight, well rounded axial ribs which become slightly enfeebled toward the summit and terminate at the periphery. Of these ribs 14 occur upon the first and second, 16 upon the third to sixth, 18 upon the ninth, and 20 upon the penultimate turn. Intercoastal spaces a little wider than the ribs, terminating abruptly, a little posterior to the suture, thus leaving a narrow, smooth, spiral band at the moderately constricted suture. Periphery of the last whorl well rounded. Base moderately long, strongly rounded, marked by incremental lines, and the fine very regularly and closely spaced wavy spiral striations. Aperture elongate oval; posterior angle acute; outer lip thin; inner lip slender, oblique, slightly revolute, without visible fold; parietal wall glazed with a thin callus.

The type, Cat. No. 267744c U.S.N.M., was dredged in shallow water in Santa Maria Bay, Lower California. It has 11 post-nuclear whorls and measures—length, 4.7 mm.; diameter, 1 mm.

TURBONILLA (STRIOTURBONILLA) DOREDONA, new species.

Plate 44, fig. 3.

Shell very regularly, broadly elongate conic, yellowish white. Nuclear whorls $2\frac{1}{2}$, strongly rounded, smooth, forming a strongly elevated spire having its axis at right angles to that of the succeeding turns,

in the first of which the side of the last volution is about one-fifth immersed. Postnuclear whorl well rounded, slightly curved at the appressed summit, marked by rather distantly spaced, slender, narrow, well-rounded axial ribs, which become somewhat flattened and enfeebled toward the summit. Of these ribs 18 occur upon the first, 16 upon the second to fourth, and 18 upon the remaining turns. Intercostal spaces about two and one-half times as wide as the ribs, terminating at little posterior to the suture, thus leaving a very narrow plain band between their termination and the summit of the succeeding turn. Suture moderately constricted. Periphery of the last whorl well rounded. Base short, strongly rounded, marked by the feeble continuations of the axial ribs, which become evanescent before reaching the middle of the base. Entire surface of the shell crossed by rather marked, subequally strong and subequally spaced deeply incised spiral striations. Aperture subquadrate; posterior angle obtuse (outer lip partly fractured); inner lip thick, almost straight, and somewhat revolute, provided with an obsolete oblique fold a little anterior to its insertion; parietal wall glazed by a fine callus.

The type, Cat. No. 268719, U.S.N.M., was dredged by the U. S. Bureau of Fisheries steamer *Albatross* at station 5678, off Redondo Point, Magdalena Bay, Lower California, in $13\frac{1}{2}$ fathoms, on broken shell bottom. It has 8 postnuclear whorls and measures—length, 4.2 mm.; diameter, 1.3 mm. The unique type is an adolescent shell, and it is quite possible that when adult specimens are obtained it will be found that the axial ribs terminate at the periphery instead of continuing feebly upon the base.

TURBONILLA (STRIOTURBONILLA) REDONDOENSIS, new species.

Plate 42, fig. 4.

Shell large, broadly elongate conic, yellowish white. Nuclear whorls decollated. Postnuclear whorls strongly rounded, with a strong sloping shoulder which extends over the posterior two-fifths of the whorls. Surface marked by strong, distantly spaced, well-rounded, regular, lamellose, slightly curved, protractively slanting axial ribs, of which 14 occur upon the first three whorls and 16 upon the rest except the last, which has 18. These ribs become somewhat enfeebled and flattened toward the summit and terminate at the periphery. Intercostal spaces about double the width of the ribs, shallow, terminating a very little posterior to the suture, thus leaving a very narrow smooth band immediately posterior to the summit of the succeeding turn. Suture quite strongly constricted. Periphery of the last turn obscurely angulated. Base short, almost flattened, marked by fine incremental lines and fine, rather regularly

and somewhat distantly spaced spiral striations. Aperture subquadrate; posterior angle obtuse; outer lip thin, showing the external sculpture within; inner lip moderately stout, almost vertical, slightly revolute, apparently without fold; parietal wall glazed by a thin callus.

The type, Cat. 268718, U.S.N.M., was dredged by the U. S. Bureau of Fisheries steamer *Albatross* at station 5678, off Redondo Point, Magdalena Bay, Lower California, in $13\frac{1}{2}$ fathoms, on broken shell bottom. It has lost the nuclear turns and probably a half of the first postnuclear whorl; the 13 remaining measure—length, 7.4 mm.; diameter, 1.9 mm.

The present species is nearest related to *Turbonilla* (*Strioturbonilla*) *humerosa* Bartsch, but differs from this by having fewer, stronger, and more distantly spaced axial ribs.

TURBONILLA (STRIOTURBONILLA) SCHMITTI, new species.

Plate 43, fig. 8.

Shell elongate conic, rather stout, bluish white. Nuclear whorls small, strongly rounded, forming a decidedly elevated spire, the axis of which is at right angles to that of the succeeding turns, in the first of which it is about one-fourth immersed. Postnuclear whorls almost flattened, somewhat excurved below the strongly tabulately shouldered summit, marked by somewhat sinuous, decidedly protractively slanting, strong, regular, well-rounded axial ribs, of which 20 occur upon the first and second, 22 upon the third, and 24 upon the remaining turns. These ribs extend strongly from the summit of the whorls, where they appear as slender cusps, to the periphery, where they terminate. Intercoastal spaces a little wider than the ribs, terminating also at the periphery. Suture rendered strongly channeled by the shouldered summit. Periphery of the last whorl well rounded. Base moderately long, well rounded, marked by strong incremental lines and the exceedingly fine, closely spaced spiral striations which cover the entire surface of the shell. Aperture oval; posterior angle narrowly squarely truncated by the flattened summit; outer lip thin, showing the external sculpture within; inner lip slender, slightly oblique, and weakly revolute, provided with a very feeble oblique internal fold at its insertion which is scarcely noticeable when the aperture is viewed squarely.

The type and two specimens of this species, Cat. No. 265739, U.S.N.M., were obtained in shallow water at Point Abreojos, Lower California. The type has 10 postnuclear whorls and measures—length, 6.3 mm.; diameter, 2 mm. One of the other specimens has 11 postnuclear whorls and measures—length, 7.3 mm.; diameter, 2.1 mm.

This species is quite unlike any of the other known west American forms. It recalls somewhat *Turbonilla* (*Strioturbonilla*) *panamensis* C. B. Adams, from Panama, in the very regular and oblique disposition of its axial ribs.

TURBONILLA (PYRGOLAMPROS) HANNIBALI, new species.

Plate 43, fig. 7.

Shell elongate conic, yellowish white. Nuclear whorls decollated. Postnuclear whorls almost flattened, narrowly shouldered at the summit, marked by ill-defined indications of axial ribs, which are entirely too poorly developed to permit counting. The spiral sculpture consists of slender, closely spaced striations. Sutures strongly impressed. Periphery of the last whorl obtusely angulated. Base moderately long, well rounded, marked like the spire. Aperture broadly oval; posterior angle acute; inner lip almost vertical, somewhat sinuous, and slightly reflected.

The type and two additional specimens, Cat. No. 252428, U.S.N.M., were collected by Mr. Harold Hannibal in the Upper Pliocene "Elk River beds," at the mouth of Elk River at Port Orford, Oregon. The type has nine postnuclear whorls and measures—length, 9 mm.; diameter, 2.5 mm.

The present species recalls *Turbonilla* (*Pyrgolampros*) *oregonensis* Bartsch, but is larger in every way than that species and has the summit of the whorls appressed, not tabulated; the spiral sculpture also is much more strongly developed. *Turbonilla* (*Pyrgolampros*) *hannibali* differs from *Turbonilla* (*Pyrgolampros*) *lituyana* Dall and Bartsch in being smaller and in having the ribs much less strongly indicated than in that species.

TURBONILLA (PYRGOLAMPROS) FRANCISCANA, new species.

Plate 42, fig. 2.

Shell elongate conic, flesh colored, excepting a broad chestnut band which covers the median third of the last whorl. This dark band really consists of two chestnut-colored zones, the anterior of which embraces half of the band while the posterior is equal to one-fourth of the width of the dark area, the two being separated by a zone of a little lighter shade which is as wide as the posterior zone. Nuclear whorls decollated in all the specimens seen. Postnuclear whorl rather high between the sutures, feebly shouldered at the summit, and slightly constricted at the periphery. Early postnuclear whorls marked by low, rounded, broad, almost vertical axial ribs which are wider than the shallow impressed spaces that separate them. On the later whorls the axial ribs become quite obsolete. On the first of the postnuclear whorls there are eighteen of these ribs;

on the second to fourth, twenty; on the fifth they become decidedly feeble; and on the remainder they are not at all differentiated. In addition to the axial sculpture the surface of the shell is marked by very fine, wavy, closely spaced spiral striations. Periphery of the last whorl well rounded. Base moderately long, well rounded, marked by lines of growth and spiral striations comparable to those on the spire. Aperture broadly oval; outer lip thin, showing the color markings within. Columella curved, somewhat twisted, and slightly revolute; parietal wall glazed with a thin callus.

The type and 17 specimens, Cat. No. 214435, U.S.N.M., was dredged by the U. S. steamer *Albatross* at station 5743, in 10-15½ fathoms, on very fine sand and mud bottom, San Francisco Bay, California. The type has lost the nucleus and probably the first of the postnuclear turns. The eight remaining measure—length, 6.8 mm.; diameter, 2 mm.

There are three additional lots of specimens in the collection of the United States National Museum, likewise dredged by the U. S. Bureau of Fisheries steamer *Albatross* in San Francisco Bay. These are: Cat. No. 214433, 3 specimens, from station 5729, in 4½ fathoms, on mud bottom; Cat. No. 214434, 16 specimens, from station 5744, in 5½ fathoms, on sandy mud bottom; Cat. No. 214436, 4 specimens, from station 5703, in 8½ fathoms, on mud bottom.

This species belongs to the obsoletely sculptured group of *Pyrgolampros*, embracing *halistrepta*, *pesa*, *rinella*, *lituyana*, and *oregonensis*.

TURBONILLA (PYRGOLAMPROS) HEMPHILLI, new species.

Plate 44, fig. 8.

Shell elongate conic. Nuclear whorls moderately large, one and one-half planorboid, having their axis at right angles to that of the succeeding turns, in the first of which they are scarcely at all immersed. The sides of the nuclear whorls project slightly beyond the outline of the spire. Postnuclear turns feebly rounded, appressed at the summit, marked by moderately strong, low, almost vertical axial ribs, which are very feeble on the first two turns, on the third and fourth there are 16, on the fifth to seventh there are 18, while on the last turn they become decidedly enfeebled and too irregular to permit counting. Intercostal spaces shallow, about as wide as the ribs. Suture moderately constricted. The summit of the whorls falls a little anterior to the periphery and gives to the whorls a slightly over-hanging appearance. Periphery inflated, well rounded. Base moderately long, well rounded, marked by the feeble continuations of the axial ribs, which extend to the umbilical chink. Entire surface marked by fine, closely spaced, spiral striations. Aperture broadly oval, posterior angle acute; outer lip thin; inner lip strongly

curved and slightly revolute; parietal wall covered with a thin callus.

The type and 21 specimens, Cat. No. 135053, U.S.N.M., were collected by Henry Hemphill in the Pliocene of a well boring, 140 feet below the surface, at San Diego, California. The type has lost the nucleus and probably half of the first postnuclear turn. The nine remaining whorls measure—length, 6.7 mm.; diameter, 1.9 mm. The nuclear whorls were described from one of the other specimens, which may be considered a paratype.

TURBONILLA (PYRGOLAMPROS) PUGETENSIS, new species.

Plate 44, fig. 4.

Shell small, elongate conic, wax yellow with a broad band of pale brown which extends posterior from the periphery, gradually fading into the general lighter color. Nuclear whorls and early postnuclear turns decollated in all our specimens; those remaining feebly shouldered at the summit, flattened in the middle, becoming considerably contracted and rounded toward the suture, marked by broad, well rounded slightly protractive axial ribs which become somewhat enfeebled and expanded toward the summit. Of these ribs 16 occur upon all of the turns remaining excepting the last which has 18. Intercostal spaces shallow, about as wide as the ribs. Suture moderately contracted. Periphery of the last whorl well rounded. Base somewhat inflated, well rounded, marked by the feeble continuations of the axial ribs which become evanescent before reaching the middle of the base and numerous very fine spiral striations which are also present on the spire. Aperture broadly oval; posterior angle acute; outer lip thin showing the external sculpture within; inner lip decidedly oblique, slender and somewhat revolute; parietal wall glazed with a very thin callus.

The type and 7 specimens, Cat. No. 268754 U.S.N.M., were obtained by the U. S. Bureau of Fisheries at Northwest Point, Elliott Bay, Seattle, Washington. The type consists of the last 5 postnuclear whorls and measures—length, 4 mm.; diameter, 1.5 mm.

TURBONILLA (PYRGOLAMPROS) TREMPERI, new species.

Plate 44, fig. 7.

Shell short, elongate conic, pale brown. Nuclear whorls a little more than two, decidedly depressed helicoid, having their axis at right angles to that of the succeeding turns, in the first of which they are about one-fifth immersed. Postnuclear whorls flattened in the middle, sloping toward the suture and the almost appressed summit, marked by strong lamellar, decidedly retractively slanting, axial ribs, of which 12 occur upon the first, 14 upon the second to fourth, 16

upon the fifth, 18 upon the sixth, and 16 upon the penultimate turn. These ribs extend prominently to the summit. Intercostal spaces strongly impressed, about $2\frac{1}{2}$ times as wide as the ribs. Suture moderately constricted. Periphery of the last whorl feebly angulated. Base short, well rounded, marked by the very feeble continuations of the axial ribs, which become evanescent before reaching the umbilical chink. Entire surface of the shell marked with fine, closely spaced, spiral striations. Aperture oval, posterior angle obtuse; outer lip thick; inner lip thick, almost straight, and slightly revolute; parietal wall covered by a thin callus.

The type, Cat. No. 250629, U.S.N.M., was collected by Mr. Gripp on kelp, in 15 fathoms, outside of San Diego Bay. It measures—length, 4.7 mm.; diameter, 1.2 mm.

TURBONILLA (PYRGISCULUS) GUILLENI, new species.

Plate 44, fig. 5.

Shell conic, milk white. Nuclear whorls $2\frac{1}{2}$, well rounded, forming a depressed helicoid spire, the axis of which is at right angles to that of the succeeding turns, in the first of which it is about one-third immersed. Postnuclear whorls somewhat inflated, well rounded, almost appressed at the summit, marked on each whorl by 18 narrow, well developed, rounded, almost vertical axial ribs. Some of these ribs are developed into varices and these are distributed at irregular intervals. Intercostal spaces about $2\frac{1}{2}$ times as wide as the ribs, crossed by three spiral series of strong pits, of which one is at the periphery, the second a little anterior to the middle and the third about two-fifths of the space between this and the summit posterior to the median pit. In addition to these pits the intercostal spaces are crossed by many almost equally strong incised spiral lines of which 12 occur between the summit and the first pit, 7 between the first and median pit, and 8 between the median and peripheral pit. Suture quite strongly constricted. Periphery of the last whorl well rounded. Base moderately long, attenuated, marked by the feeble continuations of the axial ribs and numerous incised spiral lines of a little wider spacing than the fine sculpture on the spire. Aperture rissoid, oval; posterior angle obtuse; outer lip thick; inner lip short, curved, reflected over and appressed to the base; parietal wall covered with a thick callus.

The type, Cat. No. 267736, U.S.N.M., was dredged in shallow water in Santa Maria Bay, Lower California. It has five postnuclear whorls and measures—length, 3 mm.; diameter, 1 mm.

TURBONILLA (PYRGISCUS) DORA, new species.

Plate 42, fig. 10.

Shell very large, elongate conic, uniformly pale brown. Nuclear whorls decollated. Postnuclear whorls well rounded, strongly appressed at the summit, marked on the early whorls by rather strong, almost vertical, axial ribs, which become evanescent on the later turns. Of these ribs 18 occur upon the first to fourth, 20 upon the fifth, 22 upon the sixth, 24 upon the seventh, 26 upon the eighth, 32 upon the ninth, and 34 upon the tenth, while upon the penultimate whorl they become too enfeebled to be counted. The spiral sculpture consists of broad pits and feebly incised lines, the posterior fifth between the sutures being marked by six very fine, subequally spaced, spiral striations. These are followed by two stronger lines, which are succeeded by two strongly impressed pits, these are followed by a pit about half as wide as the last two, then by one a little stronger and finer, then by the widest pit of all, which is succeeded by one not quite as broad. These incised spiral lines pass up on and even cross the summit of the enfeebled ribs. Suture moderately constricted. Periphery of the last whorl decidedly inflated. Base moderately long, somewhat inflated, well rounded, marked by about 25, somewhat wavy, more or less regular, spiral grooves of somewhat varying width, which inclose spaces between them of a width about equal to the grooves, the space between the first of these and the last on the spire is a rather wide band, devoid of sculpture, excepting the fine spiral striations, which cover the entire surface of the shell, in addition to the coarser sculpture already described. Aperture small, subquadrate, posterior angle obtuse; outer lip moderately strong; inner lip oblique, straight and slightly reflected; parietal wall covered by a thick callus.

The type, Cat. No. 250626, U.S.N.M., was collected by Mr. Gripp on kelp, in 15 fathoms, off San Diego Bay. It is minus the nucleus. The 13 remaining whorls measure—length, 13.8 mm.; diameter, 3.2 mm.

TURBONILLA (PYRGISCUS) INA, new species.

Plate 44, fig. 10.

Shell broadly, elongate-conic, bright brown, excepting the nucleus, which is white. Nuclear whorls, two and one-half, planorboid, having their axis almost at right angles to that of the succeeding turns, in the first of which they are about one-third immersed. Post-nuclear whorls feebly rounded, appressed at the summit, marked by rather feeble, almost vertical, axial ribs, of which 18 occur upon the second and third, 20 upon the fourth and fifth, and 22 upon the remaining whorls. Intercostal spaces feebly impressed, about as

wide as the ribs, crossed by eleven incised spiral lines between the sutures, of these the fifth is the widest, being fully twice as wide as the third and sixth, which are of equal strength, the remaining are much more slender and also of equal strength. In spacing the first is about as far anterior to the summit as the second is distant from the third, or the fourth from the fifth, or the fifth from the sixth, while the space between the first and second, and those between the sixth and the seventh, are about equal, the spiral markings pass up on the sides of the ribs and the stronger ones tend to cross their summit. Suture moderately constricted. Periphery of the last whorl decidedly angulated. Base short, slightly rounded, marked by the very feeble continuations of the axial ribs, which become evanescent before reaching the middle of the whorls, and thirteen incised spiral lines, which are about equally spaced, the first one below the periphery being a little nearer to its neighbor than the spacing between the rest, the space between the seventh line of the spire and the first incised spiral basal line is a broad, smooth band. Aperture subquadrate, posterior angle obtuse; outer lip thin, showing the external sculpture within; inner lip almost straight and slightly revolute; parietal wall covered with a thin callus.

The type, Cat. No. 250625, U.S.N.M., was collected by Mr. Gripp on kelp, in 15 fathoms, off San Diego Bay. It has eight and one-half postnuclear whorls, and measures—length, 6.1 mm.; diameter 1.9 mm.

TURBONILLA (PYRGISCUS) ISTA, new species.

Plate 42, fig. 6.

Shell rather large, elongate conic, light brown. Early whorls light yellow. Nuclear whorls decollated. Postnuclear whorls appressed at the summit, which is slightly excurved, marked by rather poorly developed, almost vertical, axial ribs, which become obsolete on the later whorls. Of these ribs, 18 occur upon the second and third, 20 upon the fourth, 22 upon the fifth, 24 upon the sixth, 26 upon the seventh, 28 upon the eighth, 30 upon the ninth, and 32 upon the tenth, while upon the penultimate they are too irregular to be counted. Intercostal spaces very feebly impressed, about as wide as the ribs. The spiral sculpture consists of strong and weak incised lines, the strong lines pass strongly upon the sides of the ribs and even cross the summit; the first of these strong lines is about one-fifth of the distance between the summit and the suture anterior to the summit, while the spaces between the first and second, the third and fourth, the fourth and fifth, and the fifth and sixth are almost equal and about two-thirds as wide as that between the second and third; of the finely incised spiral lines eight occur between the summit and the first strong line and three between the first and second,

the anterior member of these three being much stronger than the other two; there are also three between the second and third, the last two of these being closer spaced than the first two; no fine lines are apparent between the other strong lines. Suture slightly constricted. Periphery of the last whorl strongly inflated. Base short, well rounded, marked by the feeble continuations of the axial ribs and 22 wavy incised lines, which are of varying width and spacing. Aperture moderately large, subquadrate, posterior angle obtuse; outer lip thin, showing the external sculpture within; inner lip oblique, straight, slightly revolute; parietal wall glazed with a moderately thick callus.

The type, Cat. No. 250627, U.S.N.M., was dredged by Mr. Gripp, in 15 fathoms, on kelp off San Diego Bay. It has lost the nucleus. The $11\frac{1}{2}$ whorls remaining measure—length, 12.5 mm.; diameter, 2.8 mm.

TURBONILLA (PYRGISCUS) EVA, new species.

Plate 44, fig. 6.

Shell small, elongate conic, of pale brown ground color, with the incised spiral lines red. Nuclear whorls decollated. Postnuclear whorls gently rounded, on the posterior three-quarters of the shell sloping more abruptly toward the suture, marked by moderately strong, well-rounded, almost vertical axial ribs, of which 22 occur upon the third and fourth, 24 upon the fifth, and 26 upon the penultimate turn. Intercostal spaces a little narrower than the ribs, crossed by 11 strongly incised spiral grooves, which are of varying width. Of these the fourth, seventh, and eleventh are of equal strength and much wider than any of the rest; the remaining, with the exception of the sixth, which is a mere incised line, are of almost equal strength. In spacing the first is about as far below the summit as that is distant from the second, and these two spaces are a little wider than the spaces between the third and fourth, the fifth and sixth, and the seventh and eighth, which are equal and follow next in strength, the remaining spaces are subequal and a little narrower. Suture quite strongly constricted. Periphery of the last whorl inflated, well rounded. Base moderately long, well rounded, marked by the feeble continuations of the axial ribs, which become evanescent before reaching the middle of the base, and 12 subequally spaced incised spiral lines, of which the first three below the periphery are interrupted by the ribs. Aperture oval, posterior angle obtuse; outer lip very thin; inner lip slightly curved, reflected over and appressed to the base; parietal wall covered with a thin callus.

The type, Cat. No. 250630, U.S.N.M., was dredged by Mr. Gripp, on kelp, in 15 fathoms, off San Diego Bay. It has lost the nucleus. The seven whorls remaining measure—length, 4.3 mm.; diameter, 1.2 mm.

TURBONILLA (PYRGISCUS) ALMEJASENSIS, new species.

Plate 45, fig. 10.

Shell slender, elongate conic, milk white. Nuclear whorls decol-
lated in the type (see end of description for this character). The
early postnuclear whorls are flattened, the later ones well rounded;
all have the summit feebly shouldered. The whorls are ornamented
by very regular well rounded axial ribs which become somewhat en-
feebled toward the summit. These ribs have a decided protractive
slant on the early whorls, while on the middle turns they are ver-
tical, and on the later volutions they have a decidedly retractive
slant; here, too, they are a little less strong and less regular and
much more closely spaced. Of these ribs 18 occur upon the first four
of the remaining turns, 20 upon the fifth, 22 upon the sixth, 24 upon
the seventh, 28 upon the eighth, 34 upon the ninth, 36 upon the
tenth, and about 52 upon the last turn. Intercostal spaces a little
narrower than the ribs, marked by 15 fairly equal and equally spaced
spiral series of pits, which are about as wide as the spaces that sepa-
rate them. Of these pits the first is about one-twelfth the distance
between the first basal line and the peripheral series of pits anterior
to the summit. On the last whorl, where the axial ribs become de-
cidedly enfeebled, the combination of the axial and raised spiral
sculpture gives to the surface a thimble pitted appearance. Suture
of the early whorls slightly and of the later strongly constricted.
Periphery of the last whorl well rounded. Base attenuated, marked
by the very feeble continuations of the axial ribs, and 12 incised
spiral lines, which are of irregular strength and spacing. Aperture
broadly oval; posterior angle acute; outer lip thin; inner lip slightly
curved, decidedly oblique, revolute, and appressed to the attenu-
ated base for almost its entire length, provided with a strong very
oblique fold at its insertion; parietal wall covered by a very thick
callus.

The type, Cat. No. 266535, U.S.N.M., was dredged in shallow water
in Almejas Bay, which is really the southern arm of Magdalena Bay,
Lower California. The type had lost the nucleus and probably the
first postnuclear turn, the 12 whorls remaining measure—length,
8 mm.; diameter, 1.1 mm. Cat. No. 267747 contains two additional
specimens dredged in shallow water in Santa Maria Bay, Lower
California. From these we are able to add a description of the
nucleus. Nuclear whorls $2\frac{1}{2}$, well rounded, forming a moderately
elevated spire, the axis of which is at right angles to that of the
succeeding turns, in the first of which the tilted spire is one-fifth
immersed.

TURBONILLA (PYRGISCUS) BARTOLOMENSIS, new species.

Plate 45, fig. 5.

Shell conic, yellow. Nuclear whorls decollated. Postnuclear whorls appressed at the summit, flattened in the middle, except the last, which is inflated and strongly rounded. The whorls are marked by rather strong, well-rounded axial ribs, which are slightly retractorily slanting on the early turns and decidedly so on the later volutions. Intercostal spaces about as wide as the ribs marked by 12 deeply incised spiral pits. Of these the fifth is a mere line, while the first four, the sixth, ninth, and tenth are about twice as wide, and the eighth and ninth and eleventh and twelfth form deep broad pits fully three times the width of the last. Suture moderately constricted. Periphery of the last whorl strongly inflated, well rounded. Base short, inflated, well rounded, marked by the continuations of the axial ribs, which extend strongly to the umbilical area, between which poorly defined spiral striations may be seen. Aperture short, broadly oval, posterior angle obtuse; outer lip thin, showing the external sculpture within; inner lip short, partly reflected, free, provided with an obsolete oblique internal fold at its insertion; parietal wall covered by a very thick callus, which renders the peristome complete.

The type, Cat. No. 268729, U.S.N.M., was dredged in shallow water in San Bartolome Bay, Lower California. It has lost the nucleus, the nine postnuclear whorls measure—length, 5.6 mm.; diameter, 1.6 mm.

This special resembles *Turbonilla (Pyrgiscus) auricoma* Dall and Bartsch in having the inflated last whorl and the reddish incised spiral lines, but differs markedly from it in shape and sculpture.

TURBONILLA (PYRGISCUS) LAMNA, new species.

Plate 43, fig. 1.

Shell regularly, broadly elongate conic, yellowish white. Nuclear whorls $2\frac{1}{2}$ smooth, forming a decidedly depressed helicoid spire, the axis of which is at right angles to that of the succeeding turns in the first of which about one-fourth of the side of the spire is immersed. Postnuclear whorls well rounded, appressed at the summit, ornamented by weak, distantly spaced, somewhat protractive axial ribs, which become flattened and decidedly enfeebled near the summit. Of these ribs 20 occur upon the first and 18 upon the remaining turns. Intercostal spaces about three times as wide as the ribs, shallow, crossed by 13 slender incised spiral lines of somewhat varying width. Of these lines the first to fifth, seventh and twelfth are mere incised lines, while the sixth, eighth, tenth, and

eleventh are about twice as wide as these, and the ninth and thirteenth are double the width of the last. The space between the summit and the first is as wide as the space between the eighth and ninth, which is doubly as wide as that separating the first five lines, which are subequally spaced. The spaces between the eighth and ninth, ninth and tenth, tenth and eleventh, and eleventh and twelfth increase steadily in width, the space between the first of this series being about one-half as wide as that separating the last. Suture moderately constricted. Periphery of the last whorl angulated. Base short, well rounded, marked by the feeble continuations of the axial ribs, which become evanescent before reaching the middle of the base, and 12 feebly incised, slender, wavy, spiral striations, which become successively weaker and closer spaced from the periphery toward the umbilical area. Aperture subquadrate; posterior angle obtuse; outer lip thin; inner lip slender, slightly twisted, provided with a very oblique fold a little anterior to its insertion; parietal wall glazed with a thin callus.

The type and an additional specimen, Cat. No. 268625 U.S.N.M. was dredged along the shore of Santa Maria Bay, Lower California. It has $8\frac{1}{4}$ postnuclear whorls and measures—length, 5.2 mm.; diameter, 1.6 mm.

TURBONILLA (PYRGISCUS) MARIANA, new species.

Plate 45, fig. 9.

Shell very slender, elongate conic, light horn yellow with the anterior half of the base and a narrow band about one-fifth of the width of the space between the sutures pale brown. The band is situated about its own width posterior to the periphery. Nuclear whorls decollated. Postnuclear whorls flattened very high between the sutures, narrowly shouldered at the summit, marked by closely crowded, quite regular, well rounded, almost straight, slightly protractive axial ribs of which 18 occur upon the first four of the remaining turns; 20 upon the fifth to seventh; 22 upon the eighth, and 26 upon the penultimate whorl. Intercostal spaces a little narrower than the ribs, marked by 13 strongly incised, subequal and subequally spaced pits. Suture moderately constricted. Periphery of the last whorl well rounded. Base attenuated, well rounded, marked by the feeble continuation of the ribs which reach to the umbilical chink and five equal and equally spaced, moderately broad, shallow, incised lines of a rust brown color. Aperture elongate oval; posterior angle acute; outer lip thin, showing the external sculpture within; inner lip slender, moderately curved, reflected over and adnate to the attenuated base for two-thirds of its length and provided with a strong oblique fold at its insertion; parietal wall covered by a thick callus.

The type, Cat. No. 267722*b*, U.S.N.M., was dredged in shallow water in Santa Maria Bay, Lower California. It has lost the nucleus and probably the first two postnuclear turns; the nine and a half remaining whorls measure—length, 5.9 mm.; diameter, 1 mm.

TURBONILLA (PYRGISCUS) LAZAROENSIS, new species.

Plate 45, fig. 11.

Shell extremely slender, elongate conic, milk-white. Nuclear whorls decollated. Postnuclear whorls flattened, very high between the sutures, slightly excurved immediately below the feebly shouldered summit, and marked by very regular and regularly spaced well rounded, slightly protractive axial ribs of which 20 occur upon all the remaining turns excepting the last two. Of these the penultimate has 24 and the last 32. Intercoastal spaces a little narrower than the ribs, marked by 17 spiral series of pits of which the first 16 are subequal and subequally spaced. The last, the peripheral pit is a little wider than the rest and separated from the sixteenth by a space about five times as wide as those separating the other pits. The first pit is about as far anterior to the summit as the sixteenth is distant from the seventeenth. Suture slightly contracted. Periphery of the last whorl well rounded. Base attenuated marked by the very feeble continuation of the axial ribs and eight wavy incised spiral lines which are of about the same strength but not of equal spacing. A broad band separates the peripheral line of pits from the first basal line; the next three lines are closely and equally spaced, while the fourth is a little farther from the third than that is from the second and the distance between the fourth and fifth is in equal proportions greater than that between the third and fourth. The rest are again narrowly and about equally spaced. Aperture elongate oval; posterior angle acute; outer lip thin showing the external sculpture within by transmitted light: inner lip slightly curved reflected and appressed to the attenuated base for almost its entire length, provided with a very oblique, strong fold at its insertion; parietal wall glazed by a thin callus.

The type, Cat. No. 267742 U.S.N.M., was dredged in shallow water off Lazaro Point, Santa Maria Bay, Lower California. It has lost the nucleus and probably the first 3 postnuclear turns, the 9½ remaining measure—length, 5.8 mm.; diameter, 0.85 mm.

This species is nearest related to *Turbonilla (Pyrgiscus) mariana* Bartsch from which it differs by its much more slender form and spiral sculpture.

TURBONILLA (PYRGISCUS) CORTEZI, new species.

Plate 45, fig. 12; plate 42, fig. 7.

Shell rather large, elongate conic, pale yellowish brown. Nuclear whorls $2\frac{1}{2}$, well rounded, forming a decidedly depressed helicoid spire, the axis of which is at right angles to that of the succeeding turns in the first of which the tilted edge is about one-fifth immersed. Early postnuclear whorls well rounded, the later ones almost flattened, all appressed at the summit and marked by slender, well-rounded, low, decidedly retractive axial ribs, of which 24 occur upon the first four turns, 22 upon the fifth and sixth, 26 upon the penultimate, and 30 upon the last turn. These ribs become somewhat enfeebled and expanded toward the summit. Intercoastal spaces about two times as wide as the ribs, crossed by seven spiral series of pits, of which the second, third, sixth, and seventh are equal and stronger than the rest; the other three being about half as wide and equal. In addition to the above sculpture the entire spire is marked by fine incremental lines and equally fine spiral striations, the combinations of which give to the surface a clothlike texture. Suture feebly impressed. Periphery of the last whorl well rounded. Base moderately long, strongly rounded, marked by incremental lines and 8 rather broad, somewhat wavy, subequal, and subequally spaced spiral lines. The white color of these and the incised stronger lines on the spire stand out in marked contrast to the ground color. Aperture elongate oval; slightly effuse anteriorly; posterior angle acute; outer lip thin, showing the external sculpture within; inner lip almost straight, slightly revolute; parietal wall glazed with a thin callus.

The type and two additional specimens, Cat. No. 267722, U.S.N.M., were dredged in shallow water in Santa Maria Bay, Lower California. The type is an adolescent specimen and has $8\frac{1}{4}$ post-nuclear turns, and measures—length, 6.5 mm.; diameter, 1.9 mm.

One of the other specimens is adult, but has lost the nucleus and probably the first three postnuclear turns. The eight remaining measure—length, 8.3 mm.; diameter, 2.5 mm. This specimen also enables us to say that the last whorl is inflated and that the axial ribs become obsolete on this turn.

TURBONILLA (PYRGISCUS) TECALCO, new species.

Plate 45, fig. 4.

Shell broadly elongate conic, milk white. Nuclear whorls $2\frac{1}{2}$, well rounded, forming a decidedly depressed helicoid spire, having its axis at right angles to that of the succeeding turns, in the first of which it is about one-fourth immersed. Postnuclear whorls flattened in the middle, weakly rounded at the summit, marked by very regular,

well-rounded, narrow, almost straight, slightly protractive axial ribs, of which 18 occur upon all the turns. Intercostal spaces about $2\frac{1}{2}$ times as wide as the ribs, crossed by 9 incised spiral lines, of which the third and ninth are equal, and fully doubly as wide as the second, fourth, and eighth, which are also equal, the rest being well-incised, slender striations. In spacing the first is about as far anterior to the summit as it is distant from the second, and the second is an equal distance from the third; the third, fourth, eighth, and ninth have about the same spacing, while the space between the fourth and fifth and seventh and eighth is only about one-half as wide, the combined spaces between the fifth and seventh are about equal to one of the spaces of the last-mentioned group, the sixth spiral giving a little wider spacing to the area between the fifth and sixth than the sixth and seventh. Suture moderately constricted. Periphery of the last whorl obtusely angulated. Base short, well rounded, marked by the feeble continuations of the axial ribs, which become evanescent on its middle, and nine very slender and almost equally spaced, incised lines. Aperture subquadrate. Posterior angle obtuse (outer lip badly fractured); inner lip very thick and provided with a strong oblique fold a little anterior to its insertion; parietal wall glazed with a thin callus.

The type, an adolescent specimen, Cat. No. 268731, U.S.N.M., was dredged by the U. S. Bureau of Fisheries steamer *Albatross* at station 5678 off Redondo Point, Magdalena Bay, Lower California, in $13\frac{1}{2}$ fathoms, on broken-shell bottom. It has $7\frac{1}{2}$ postnuclear whorls and measures—length, 3.9 mm.; diameter, 1.25 mm. Cat. No. 267743, U.S.N.M., contains an adult specimen dredged in shallow water in Santa Maria Bay, Lower California, which has lost the nucleus and probably the first three postnuclear turns, the $7\frac{1}{2}$ remaining measure—length, 5.3 mm.; diameter, 1.8 mm.

TURBONILLA (PYRGISCUS) CORSOENSIS, new species.

Plate 45, fig. 8.

Shell elongate conic, pale yellowish brown. Nuclear whorls $2\frac{1}{2}$, well rounded, forming a very depressed helicoid spire, the axis of which is at right angles to that of the succeeding turns in the first of which it is about one-fourth immersed. Postnuclear whorls flattened in the middle, slightly shouldered at the summit, marked by rather low, narrow, well-rounded, slightly retractorily slanting axial ribs, of which 18 occur upon the first, 16 upon the second to fourth, and 18 upon the remaining turns. The ribs become slightly flattened and enfeebled toward the summit. Intercostal spaces about $2\frac{1}{2}$ times as wide as the ribs crossed by nine almost equally spaced incised spiral grooves, the first of which is about as far anterior to the summit as that is

distant from the second. Of these lines the first and second are the weakest, while the fourth and ninth are the strongest, the rest being intermediate. In addition to this sculpture there are many fine incremental lines and equally fine spiral striations on the spire which give the surface a fine clothlike texture. Suture well impressed. Periphery of the last whorl well rounded. Base short, strongly rounded, marked by the feeble continuations of the axial ribs, which become evanescent before reaching its middle, and eight almost equal and equally spaced incised spiral lines. Aperture broadly oval; posterior angle acute; outer lip thin, showing the external sculpture within; inner lip almost straight, oblique, somewhat revolute, and provided with a strong fold a little anterior to its insertion; parietal wall covered with a thick callus.

The type and four additional specimens, Cat. No. 267722a, U.S.N.M., were dredged in shallow water in Santa Maria Bay, Lower California. The type has $9\frac{1}{2}$ postnuclear whorls and measures—length, 6.1 mm.; diameter, 1.7 mm. Cat. No. 268730, U.S.N.M., contains another specimen dredged by the U. S. Bureau of Fisheries steamer *Albatross* at station 5678 off Redondo Point, Magdalena Bay, Lower California.

TURBONILLA (PYRGISCUS) BAEGERTI, new species.

Plate 45, fig. 2.

Shell elongate conic, light yellow horn colored. Nuclear whorls $2\frac{1}{2}$, well rounded, forming a decidedly depressed helicoid spire, the axis of which is at right angles to that of the succeeding whorls, in the first of which the tilted edge of the nucleus is about one-fifth immersed. Postnuclear whorls flattened, slopingly shouldered toward the summit, marked by distinctly spaced, well-rounded, very regular, slightly retractorily slanting axial ribs of which 18 occur upon the first five and 20 upon the remaining turns. These ribs become decidedly enfeebled and somewhat flattened toward the summit. Intercostal spaces about twice as wide as the ribs crossed by 12 incised spiral lines of which the first to fourth, and the sixth, ninth, and tenth are mere striations while the fifth, seventh, eighth, eleventh, and twelfth are subequal and much stronger. The widest space is between the tenth and eleventh line, the rest of the spacing is subequal, excepting the first four lines below the summit, which are a little more closely crowded. Suture strongly constricted. Periphery of the last whorl well rounded. Base short, well rounded, marked by the feeble continuation of the axial ribs which become evanescent before reaching the middle of the base and 16 rather closely crowded finely incised spiral lines, the first of which is considerably anterior to the first series of supraparipheral pits. Aperture large, broadly

oval; posterior angle obtuse; outer lip thin, showing the external sculpture within; inner lip stout, slightly curved and somewhat revolute, provided with a moderately strong oblique fold a little anterior to its insertion. Parietal wall covered with a thin callus.

The type, Cat. No. 267744a, U.S.N.M., was collected in shallow water in Santa Maria Bay, Lower California. It has nine post-nuclear whorls and measures—length, 4.8 mm.; diameter, 1.4 mm.

TURBONILLA (PYRGISCUS) ULLOA, new species.

Plate 43, fig. 4.

Shell elongate conic, yellowish white. Nuclear whorls and all but the last $5\frac{1}{2}$ postnuclear turns decollated. The whorls remaining are flattened, almost appressed at the summit, marked by 18 quite regular, slightly protractively slanting, well-rounded axial ribs. Intercostal spaces shallow, about two times as wide as the ribs, crossed by eight incised spiral grooves, of which the second, third, seventh, and eighth are of equal width and much stronger than the rest; the remaining four are also of equal width, but only about one-fourth as wide as the rest. The spaces between the first and second and second and third are equal and almost doubly as wide as those between the summit and the first, the third and fourth, and sixth and seventh; the space between the seventh and eighth is a trifle narrower than the last mentioned, and those between the fourth and fifth and fifth and sixth are a little less wide than this. Suture moderately constricted. Periphery of the last whorl well rounded. Base moderately long, well rounded, marked by the feeble continuations of the axial ribs, which become evanescent before reaching the middle of the base, and 11 strongly incised subequally spaced lines. These is a broad smooth band below the periphery equal to the space between the first and second incised line on the spire of the last whorl. Aperture broadly oval, posterior angle acute; outer lip thin, showing the external sculpture within; inner lip slender, very oblique, and decidedly revolute, provided with a moderately strong fold immediately below the insertion; parietal wall covered by a thick callus.

The type, Cat. No. 267744e, U.S.N.M., was dredged in shallow water in Santa Maria Bay, Lower California. It consists of a little more than the last five whorls and measures—length, 4 mm.; diameter, 1.2 mm.

TURBONILLA (PYRGISCUS) CABRILLOI, new species.

Plate 45, fig. 3.

Shell broadly elongate conic, pale yellow horn colored. Nuclear whorls $2\frac{1}{2}$, well rounded, forming a decidedly depressed helicoid spire having its axis at right angles to that of the succeeding whorls, in the first of which the tilted edge is about one-fourth immersed.

Postnuclear whorls strongly roundly shouldered at the summit, flattened in the middle, crossed by strong sublamellar, slightly protractively slanting axial ribs, of which 16 occur upon the first and second and 18 upon the remaining turns, excepting the last, which has 20. Intercoastal spaces about one and one-half times as wide as the ribs, crossed by 11 incised spiral lines, of which the first three are mere striations, while the fourth and the peripheral are wider than the rest, which are about half their width. Suture rather strongly constricted. Periphery of the last whorl well rounded. Base short, narrowly umbilicated, marked by the feeble continuations of the axial ribs, which become evanescent before reaching the middle of the base and seven equal incised spiral lines, of which the first three occupy about as much space as that separating the third from the fourth; the rest become successively closer spaced anteriorly. The space between the first basal line and the peripheral pit is a very broad smooth band. Aperture very broadly oval; posterior angle acute; outer lip thin, showing the external sculpture within; inner lip thin, slightly curved and somewhat revolute, provided with a weak oblique fold at its insertion; parietal wall covered with a thick callus.

The type, Cat. No. 268783 U.S.N.M., was dredged by the U. S. Bureau of Fisheries steamer *Albatross* at station 5678 off Redondo Point, Magdalena Bay, Lower California, in 13½ fathoms, on broken-shell bottom. It has 9½ postnuclear whorls and measures—length, 5.5 mm.; diameter, 1.6 mm.

TURBONILLA (CINGULINA) URDENETA, new species.

Plate 45, fig. 1.

Shell elongate-conic, yellowish white, semi-translucent. Nuclear whorls deeply obliquely immersed in the first of the succeeding turns above which only the tilted edge of the last volution projects. Post-nuclear whorls well rounded, the first smooth, the second with 2, and the next three with 3 spiral keels, while the rest have 4 between the summit and the suture. The summits of the whorls are feebly shouldered; the first spiral keels fall on the anterior termination of the posterior third of the whorls between the summit and the suture, the space between the summit and this keel being concave. The second and third keels are as strong as the first and are separated from each other by a space a little more than half the width of that between the first and the summit, while the fourth keel is separated from the third by only half that space. The entire surface of the spire, excepting the summit of the keels is crossed by numerous closely spaced very slender axial threads and microscopic spiral striations. Suture strongly constricted. Periphery well rounded.

Base moderately long, well rounded, marked by the fine axial incremental threads, and closely spaced, fine, wavy, spiral striations. Aperture broadly oval, somewhat effuse anteriorly; posterior angle acute; outer lip thin showing the external sculpture within and rendered sinuous at the edge by the strong markings; inner lip very slender, strongly curved, reflected over, and appressed to the base for half its length; parietal wall covered by a thin callus.

The type, and 42 specimens, Cat. No. 267740, were dredged in shallow water in Santa Maria Bay, Lower California. The type has $8\frac{1}{2}$ postnuclear whorls and measures—length, 5.7 mm.; diameter, 1.5 mm. Cat. No. 266536 U.S.N.M. contains another specimen dredged in shallow water in Magdalena Bay, Lower California, and Cat. No. 268640 U.S.N.M. contains three dredged by the U. S. Bureau of Fisheries steamer *Albatross* at station 5678, off Redondo Point, Magdalena Bay, Lower California, in $13\frac{1}{2}$ fathoms on broken shell bottom.

TURBONILLA (MORMULA) SEBASTIANI, new species.

Plate 42, fig. 9.

Shell large, elongate-conic, pale brown. Nuclear whorls $2\frac{1}{2}$, decidedly depressed helicoid, having their axis at right angles to that of the succeeding turns, in the first of which the tilted edge is about one-fourth immersed. Postnuclear whorls well rounded, almost appressed at the summit, crossed by well-rounded, sublamellar, slightly protractively slanting axial ribs, of which 18 occur upon the first, 16 upon the second to seventh, 18 upon the eighth to tenth, and 20 upon the remaining turns. In addition to the axial ribs the whorls are marked at irregular intervals by rather ill-defined varices. Intercostal spaces about three times as wide as the ribs crossed by 14 incised spiral lines, of which the fourth, sixth, and fourteenth are equal and much stronger than the rest. These are followed by the second, eighth, eleventh, and thirteenth, which are also of equal width but only about half as wide. The rest are also subequal and about half as strong as the last named series. Suture moderately constricted. Periphery obscurely angulated. Base short, well-rounded, marked only by incremental lines and eight strong, incised, spiral lines which decrease successively in spacing from the periphery anteriorly. Aperture small, subquadrate; posterior angle obtuse; outer lip very thick, reenforced within by three spiral lamellae of which the posterior two are very strong while the anterior one is feeble. The median fold is about opposite the periphery of the last whorl, while the posterior divides the space between this and the posterior angle of the aperture in two equal parts. The anterior is a trifle farther from the median than that is from the posterior fold. Inner

lip very thick, almost straight, provided with an obscure, very oblique fold a little anterior to its insertion; parietal wall glazed by a thin callus.

The type Cat. No. 268634 U.S.N.M. was dredged by the U. S. Bureau of Fisheries steamer *Albatross* at station 5678, off Redondo Point, Magdalena Bay, Lower California. It has 14 postnuclear whorls and measures—length, 10 mm.; diameter, 2 mm.

UGARTEA, new subgenus.

Turbonillas with a fold on the parietal wall.

Type.—*Turbonilla* (*Ugartea*) *juani* Bartsch.

TURBONILLA (UGARTEA) JUANI, new species.

Plate 43, fig. 5.

Shell broadly elongate conic, bluish white. Nuclear whorls at least 2, planorboid, having their axis almost at right angles to that of the succeeding turns, in the first of which they are about half immersed. Postnuclear whorls appressed at the summit with a strong sloping shoulder, which extends over the posterior fourth of the space between the summit and the suture, the rest flattened; marked by strong, rounded, distantly spaced, almost vertical, axial ribs of which 14 occur upon the first and 12 upon all the remaining, excepting the last, which has 14. The ribs form cusps at the anterior angle of the shoulder, anterior to which they become enfeebled. Intercostal spaces shallow, about $2\frac{1}{2}$ times as wide as the ribs, marked by closely spaced microscopic spiral striations only. Immediately behind the aperture on the last turn the ribs become obsolete. Suture moderately impressed. Periphery of the last whorl rounded. Base prolonged, marked by the continuation of the axial ribs, which become evanescent before reaching the middle. Aperture narrowly oval; posterior angle acute; outer lip thick within, provided with three lamellar denticles on the inner surface; inner lip short, strong decidedly revolute continuing posteriorly into the very strong parietal callus, which becomes disjunct from the preceding whorl at the outer edge, which renders the peritreme complete. The inner lip is provided with a strong oblique fold at its insertion, while the parietal wall bears a short fold about halfway between this and the posterior angle of the aperture.

The type and another specimen, Cat. No. 268638, U.S.N.M., were collected by the U. S. Bureau of Fisheries steamer *Albatross* at station 5678, off Redondo Point, Magdalena Bay, Lower California in $13\frac{1}{2}$ fathoms on broken shell bottom. The type has seven postnuclear whorls and measures—length, 4.2 mm.; diameter, 1.3 mm.

TURBONILLA (MORMULA) VISCAINOI, new species.

Plate 43, fig. 3.

Shell elongate-conic, yellowish-white. Nuclear whorls two, well rounded, forming a moderately elevated helicoid spire, the axis of which is at right angles to that of the succeeding turns, in the first of which the tilted edge is about one-third immersed. Postnuclear whorls well rounded, almost appressed at the summit, crossed by strong, low, well-rounded, distantly spaced, protractive axial ribs, of which 14 occur upon the first and second, 16 upon the third to sixth, and 18 upon the remaining turns. In addition to the ribs the whorls are marked at irregular intervals by rather strong varices. Inter-costal spaces about three times as wide as the ribs, crossed by five spiral pits, which, if the second were a little more anterior, would divide the space between the summit and the fifth pit, which is at the periphery, into five equal spaces. The spaces between these slender pits are crossed by many very fine spiral striations, of which there are about 13 between the summit and the first pit, 5 between the first and second, 9 between the second and third, 11 between the third and fourth, and 6 between the fourth and peripheral pit. Suture moderately constricted. Periphery of the last whorl well rounded, base short, well rounded, marked by the feeble continuations of the axial ribs, which become evanescent before reaching the middle of the base and many fine wavy spiral striations which agree with those on the spire in strength and spacing. Aperture short, subquadrate, posterior angle obtuse; outer lip thin, showing the external sculpture within, reenforced within by four slender spiral lamellæ, two of which are anterior and two posterior to the periphery; inner lip slightly flexuose, almost straight, and somewhat revolute; parietal wall glazed with a very thin callus.

The type Cat. No. 268734 U.S.N.M. was dredged by the U. S. Bureau of Fisheries steamer *Albatross* at station 5678, off Redondo Point, Magdalena Bay, Lower California, in 13½ fathoms on broken shell bottom. The type has nine postnuclear whorls and measures—length, 4.3 mm.; diameter, 1.2 mm.

ODOSTOMIA (CHRYSAEIDA) TARAVALI, new species.

Plate 46, fig. 3.

Shell elongate-conic, semitransparent, bluish white. Nuclear whorls, at least 2, well rounded, forming a planorboid spire, the axis of which is almost at right angles to that of the succeeding turns, in the first of which the nuclear spire is about half obliquely immersed. Postnuclear whorls flattened, narrowly, tabulatedly shouldered at the summit, marked by strong, well-rounded, retractive axial ribs, of

which 18 occur upon the first and 16 upon the remaining whorls, except the last, which has 20. These ribs pass prominently from the shoulder to the peripheral sulcus. In addition to the axial sculpture the first 4 turns are crossed by 4 equal and equally spaced, flattened spiral cords, which are about as wide as the spaces that separate them. On the rest of the turns the subperipheral cord comes into the suture and on the penultimate whorl forms a well-developed 5-spiral cord on the spire. The spaces enclosed by the axial ribs and spiral cords are deeply impressed oblong pits, while the junction of the ribs and spiral cords form well-rounded tubercles. Suture of the early turns, where the fifth spiral is still below the summit of the succeeding turn, deeply channeled, less so on the later whorls. Periphery of the last turn strongly rounded. Base short, inflated, strongly rounded, marked by nine strong, rounded, spiral cords which are almost equal and as wide as the spaces that separate them. The grooves between these spiral cords are crossed by numerous slender axial riblets. Aperture oval; posterior angle obtuse; outer lip thin rendered sinuous by the external sculpture; inner lip slender, thin, somewhat revolute, provided with a strong oblique fold at its insertion. Parietal wall covered by a thin callus.

The type, Cat. No. 267743a U.S.N.M. was dredged in shallow water in Santa Maria Bay, Lower California. It has seven postnuclear whorls and measures—length, 3.8 mm.; diameter, 1.3 mm.

Another specimen, Cat. No. 268635 U.S.N.M. was dredged by the U. S. Bureau of Fisheries steamer *Albatross* at station 5678, off Redondo Point, Magdalena Bay, Lower California, in 13½ fathoms, on broken shell bottom.

ODOSTOMIA (CHRYSAEIDAE) SANTAMARIENSIS, new species.

Plate 46, fig. 1.

Shell stout, oval, yellowish white. Nuclear whorls decollated, the pit left in the apex of the type shows that it must have been strongly immersed in the first of the postnuclear turns. Postnuclear whorls strongly rounded, feebly shouldered at the summit, marked by rather slender axial ribs, of which 20 occur upon all the turns. In addition to the axial ribs the whorls are marked by 5 spiral cords, which are a little stronger than the ribs. The cords are about as wide as the spaces that separate them, their junctions with the ribs form rounded tubercles, while the spaces inclosed between them are strongly impressed concaved pits. Suture not channeled. Base rather long, somewhat inflated, well rounded, marked by 10 strong spiral cords, which decrease in size gradually and regularly from the periphery to the umbilical chink. The grooves between these spiral cords, which are about equal to the cords in width, are armed by

numerous slender axial riblets. Aperture oval, decidedly effuse anteriorly; posterior angle acute; outer lip thin, rendered wavy at the edge by the external sculpture; inner lip long, oblique, curved, somewhat revolute, provided with a strong oblique fold at its insertion; parietal wall covered by a moderately thick callus.

The type, Cat. No. 266180, U.S.N.M., was dredged in shallow water in Santa Maria Bay, lower California. It has $4\frac{1}{2}$ postnuclear whorls and measures, length, 3.5 mm.; diameter, 1.9 mm.

ODOSTOMIA (EVALEA) VALERIOI, new species.

Plate 46, fig. 7.

Shell ovate, narrowly umbilicated, thin, bluish white. Nuclear whorls small, completely, deeply, obliquely immersed in the first of the succeeding turns. Postnuclear whorls inflated, strongly rounded, appressed at the summit, crossed by numerous very fine, closely spaced spiral striations. Suture moderately constricted. Periphery of the last whorl inflated, well rounded. Base short, inflated, strongly rounded, narrowly umbilicated. Aperture broadly oval; posterior angle obtuse; outer lip thin, protracted between the summit and periphery to form a claw-like element; inner lip decidedly curved, slender, and somewhat revolute, provided with a strong oblique fold at its insertion; parietal wall glazed with a thin callus.

The type and another specimen, Cat. No. 266545, U.S.N.M., were dredged in shallow water in Magdalena Bay, lower California. The type has five postnuclear whorls and measures, length, 3 mm; diameter, 1.7 mm. Six additional specimens, Cat. No. 267754, U.S.N.M., were dredged in shallow water in Santa Maria Bay, lower California.

ODOSTOMIA (EVALEA) FRANCISCANA, new species.

Plate 45, fig. 7.

Shell thin, broadly elongate conic, yellowish white. Nuclear whorls small, deeply embedded in the first of the succeeding turns, above which the tilted edge of the last volution only projects. Postnuclear whorls inflated, well rounded, feebly shouldered at the summit, marked by almost vertical, very feeble, incremental lines and exceedingly fine, closely spaced, spiral striations. Suture moderately constricted. Periphery of the last whorl very feebly angulated. Base short, inflated, well rounded, with a very narrow umbilical chink. Aperture large; posterior angle acute; outer lip thin; inner lip strongly curved, somewhat reflected and provided with a strong, oblique fold at its insertion; parietal wall glazed with a thin callus.

The type and three specimens, Cat. No. 214431, U.S.N.M., were collected at United States Bureau of Fisheries Station 5729, in San

Francisco Bay, on sticky, nearly black, mud in $4\frac{1}{2}$ fathoms. Cat. No. 214432, U.S.N.M., contains four additional specimens, also from San Francisco Bay, dredged at U. S. Bureau of Fisheries Station 5781, on coarse sand, pebbly and shell bottom, in $9\frac{1}{2}$ to 16 fathoms.

ODOSTOMIA (EVALEA) WILLETTI, new species.

Plate 43, fig. 6.

Shell large, elongate conic, bluish white. Nuclear whorls obliquely immersed in the first of the succeeding turns, above which the tilted edge of the last volution only projects. Postnuclear whorls moderately rounded, appressed at the summit, the early ones marked by a moderate number of strongly incised lines, while on the later whorls the incised spiral lines are finer and much more numerous, in addition to the spiral sculpture the whorls are marked by decidedly retractorily slanting, incremental lines. Suture moderately constricted. Periphery of the last whorl inflated, feebly angulated. Base attenuated, moderately rounded. Aperture oval, somewhat effuse anteriorly; posterior angle acute; outer lip thin; inner lip very oblique, stout, slightly curved, reflected over and appressed to the base, provided with a strong oblique fold at its insertion; parietal wall covered with a thick callus.

The type, Cat. No. 274007, U.S.N.M., was dredged by Mr. G. Willett, at Waterfall Cannery, west side of Prince of Wales Island, Alaska. It has almost seven postnuclear whorls and measures—length, 5.8 mm.; diameter, 2.4 mm. Another specimen from the same locality is in Mr. Willett's collection.

ODOSTOMIA (EVALEA) PLEIOREGONA, new species.

Plate 42, fig. 5; plate 45, fig. 6.

Shell broadly conic, white. Nuclear whorls deeply immersed in the first of the succeeding turns, above which the tilted edge of the last volution only projects. Postnuclear whorls flattened, appressed at the summit, all of them marked by very fine, closely spaced, spiral striations and decidedly retractorily slanting, fine incremental lines. Suture moderately impressed. Periphery of the last whorl inflated, obtusely angulated. Base short, well rounded. Aperture large, slightly effused anteriorly; posterior angle acute; outer lip thin; inner lip oblique, slightly revolute, and appressed to the base for its posterior half and provided with a strong, oblique fold at its insertion; parietal wall covered with a thick callus.

The two cotypes, Cat. No. 252430, U.S.N.M., were collected by Harold Hannibal in the upper Pliocene, Elk River beds, at the mouth of Elk River, near Port Orford, Oregon. One of these is a young

specimen, having five postnuclear whorls, which measures—length, 3.6 mm.; diameter, 2.1 mm. The other is an adult, having three and one-fifth postnuclear whorls, and measures—length, 4.8 mm.; diameter, 2.8 mm.

I confused this species previously with *Odostomia (Evalea) stephensi* Dall and Bartsch, which is a recent form, but additional material of *O. stephensi* makes it necessary to change my opinion and requires that this be described as new.

ODOSTOMIA (EVALEA) ORFORDENSIS, new species.

Plate 43, fig. 2.

Shell small, oval. Nuclear whorls decollated. Postnuclear whorls appressed at the summit, well rounded, marked by slightly retractorily slanting, incremental lines and exceedingly fine spiral striations. Suture moderately constricted. Periphery of the last whorl well rounded. Base moderately long, well rounded. Aperture oval; posterior angle acute; inner lip curved and appressed to the base; parietal wall covered with a thick callus.

The type, Cat. No. 252431, U.S.N.M., was collected by Harold Hannibal in the upper Pliocene, Elk River bed, at the mouth of Elk River, at Port Orford, Oregon. It consists of the last three and one-half postnuclear whorls and measures—length, 3 mm.; diameter, 1.6 mm.

This form I had previously identified as *Odostomia (Evalea) valensi* Dall and Bartsch, which is a recent form, but additional material makes it possible to determine the limits of variation of it and also requires that this shell be given a distinct name.

ODOSTOMIA (EVALEA) ANDERSONI, new name.

Eulimella californica ANDERSON and MARTIN, Proc. Cal. Acad. Sci., 1914, p. 67, pl. 7, figs. 19a, 19b, and 19c, not *Odostomia (Evalea) californica* Dall and Bartsch, Bull. 68, U. S. Nat. Mus., 1909, pp. 20-25.

This is an *Odostomia* belonging to the subgenus (*Evalea*); the name *californica* being preoccupied makes the new name necessary. The specimens were collected in the Lower Miocene in the bottom of a small canyon, about 1½ miles due north of Barker's ranch house, Kern County, California.

The type No. 141 and cotype No. 142 are in the California Academy of Sciences. The type measures—length, 4.5 mm.; diameter, 2 mm.

ODOSTOMIA (ODOSTOMIA) ORCUTTI, new species.

Plate 46, fig. 8.

Shell minute, pupoid, pale brown, marked by retractorily slanting, incremental lines only. Nuclear whorls deeply immersed in the first

of the succeeding turns. Postnuclear whorls slightly rounded and appressed at the summit, the summit of the last one dropping some little distance below the periphery of the preceding whorl gives to the penultimate whorl an overhanging aspect. Suture moderately impressed. Periphery of the last whorl slightly inflated. Base moderately long, strongly rounded, with a narrow umbilical chink. Aperture oval; outer lip thin; inner lip slightly curved, strongly reflected, and provided with a very strong, oblique fold a little anterior to its insertion; parietal wall covered with a moderately thin callus.

The type, Cat. No. 274006, U.S.N.M., was dredged by C. R. Orcutt near the foot of Broadway in San Diego Bay, California. It has four and one-fifth postnuclear whorls and measures—length, 1.5 mm.; diameter, 0.8 mm.

The minute size and pupoid shape distinguish the shell at once from any of the Western American *Odostomias*.

CERITHIOPSIS (CERITHIOPSIS) CHARLOTTENSIS, new species.

Plate 46, figs. 9, 11.

Shell elongate conic, pale brown. Nuclear whorls strongly rounded, three, forming a slender very elevated spire, smooth. Postnuclear whorls well rounded, appressed at the summit, marked by rather strong, almost vertical axial ribs of which 14 occur upon the first four turns, 16 upon the fifth, 18 upon the sixth, and 20 upon the penultimate whorl. Intercostal spaces a little wider than the ribs. The spiral sculpture consists of three strong cords, of which the one at the summit is a little less strong than the other two. The junction of the spiral cords and the axial ribs form strong tubercles, those on the cord at the summit are well rounded, while those of the median cord are truncated anteriorly and posteriorly. The tubercles of the third cord are truncated posteriorly and sloped gently anteriorly. The spaces inclosed between the spiral cords and the axial ribs are well-rounded pits. Suture moderately constricted. Periphery of the last whorl marked by a spiral groove, which equals in strength and width the groove that separates the median from the third cord on the spire. Base short, well rounded, smooth, excepting the exceedingly fine incremental lines and microscopic spiral striations which are also present on the spire and a very slender basal fasciole which surrounds the insertion of the inner lip. Aperture decidedly channeled anteriorly; posterior angle obtuse; outer lip thin, showing the external sculpture within, decidedly sinuous at the edge; inner lip rendered decidedly flexuose; parietal wall covered by a thin callus.

The type and three paratypes, Cat. No. 225185, U.S.N.M., were collected by the U. S. Bureau of Fisheries steamer *Albatross*, at station 4205, in 60 fathoms, on mud bottom; bottom temperature 47.6° in Queen Charlotte Sound, British Columbia. The type, which has lost the first 2 nuclear whorls, has $7\frac{1}{2}$ postnuclear turns and measures—length, 5 mm.; diameter, 1.7 mm. The nuclear whorls were described from one of the paratypes.

CERITHIOPSIS (CERITHIOPSIS) GRIPPI, new species.

Plate 46, fig. 12.

Shell of medium size, chestnut brown. Nuclear whorls $4\frac{1}{2}$, smooth, well rounded, forming a moderately elevated apex, which is transparent. Postnuclear whorls narrowly shouldered at the summit, moderately rounded in the middle, decidedly contracted from the last spiral cord to the suture, marked by slender, slightly retractive axial ribs, of which 14 occur on the first, 16 upon the second and third, 18 upon the fourth and fifth, and 20 upon the remaining turns. Intercostal spaces about half as wide as the ribs. In addition to this axial sculpture, the whorls are marked by three strong spiral cords, of which the one at the summit is a trifle weaker than the other two. The junction of the axial ribs and the spiral cords form very prominent, well rounded tubercles, of which those on the first and median cords are well rounded, while those on the third cord are truncated posteriorly and sloped gently anteriorly. The spaces inclosed between the cords and the axial ribs are well-rounded, well-impressed pits. Suture almost channeled. Periphery of the last whorl marked by a broad groove, which is a little wider than the groove between the median and the third cord. The axial ribs extend across this groove, but stop at its anterior limit. Base short, well rounded, marked by 2 strong spiral grooves, of which one is on the median part, while the other encircles the insertion of the inner lip. The entire surface of the spire and the base is marked by very fine incremental lines and much finer spiral striations. Aperture of irregular shape, decidedly channeled anteriorly; posterior angle very obtuse; outer lip somewhat effuse, rendered decidedly sinuous at the edge by the external sculpture; columella very strong; inner lip reflected and appressed to the columella. Parietal wall covered by a thin callus.

The type and another specimen, Cat. No. 250632, U.S.N.M., were collected by Mr. Gripp, in 15 fathoms, outside of kelp, off San Diego Bay, California. The type has $8\frac{1}{2}$ postnuclear whorls and measures—length, 4.7 mm.; diameter, 1.2 mm. Two additional specimens in Mr. Gripp's collection were examined.

CERITHIOPSIS (CERITHIOPSIS) BAKERI, new species.

Plate 46, fig. 10.

Shell of medium size, chestnut brown. Nuclear whorls $3\frac{1}{2}$, well rounded, smooth, forming a styliform apex. Postnuclear whorls well rounded, narrowly, tabulatedly shouldered at the summit, and decidedly contracted anterior to the third keel, marked by rather slender axial ribs, of which 18 occur upon the first to fourth, 20 upon the fifth, 22 upon the sixth, and 24 upon the last turn. Inter-costal spaces about $1\frac{1}{2}$ times as wide as the ribs. In addition to the axial sculpture the whorls are marked by three strong spiral keels of which the first, which is considerably weaker than the rest, is at the summit. These keels are about as wide as the spaces that separate them and are much stronger than the axial ribs. The junctions of the axial ribs and the spiral keels form tubercles. The tubercles on the first keel are well rounded, while those on the second and third are truncated posteriorly and slope gently anteriorly. Periphery of the last whorl marked by a deep spiral groove which is as wide as that separating the median from the third keel. This groove is crossed by the continuations of the axial ribs which stop at the anterior termination of the groove. Suture strongly channeled. Base moderately long, slightly concave, marked by a very strong spiral keel immediately anterior to the peripheral groove. The anterior border of this keel is limited by a slender incised line. A second low, weakly developed spiral cord encircles the middle of the base between the basal fasciole, which is a mere slender thread at the insertion of the columella, and the keel immediately anterior to the periphery. Aperture of irregular shape, decidedly channeled anteriorly; posterior angle obtuse; outer lip thin, rendered sinuous at the edge by the strong external sculpture; inner lip decidedly flexuose, reflected over and adnate to the base; parietal wall covered with a moderately thick callus.

The type, Cat. No. 223049, U.S.N.M., was collected by Dr. Fred Baker in 7-10 fathoms, south of Coronado Island, California. It has $7\frac{1}{2}$ postnuclear whorls and measures—length, 4.2 mm.; diameter, 1.5 mm.

CERITHIOPSIS (CERITHIOPSIS) HELENA, new species.

Plate 46, fig. 2.

Shell very small. Nuclear whorls $4\frac{1}{2}$, light yellow, slightly rounded, separated by a moderately constricted suture forming an acicular apex. Postnuclear whorls chestnut brown, excepting the first keel which is white on all the whorls, tabulatedly shouldered at the summit, moderately rounded and strongly constricted below the

third spiral keel, marked by rather feeble axial ribs, which are slightly retractive. Of these ribs, 16 occur upon the first and second, 18 upon the third, 20 upon the fourth, and 24 upon the penultimate whorl. The spiral sculpture consists of three strong keels which are a little wider than the spaces that separate them and considerably wider than the axial ribs. The first of these is at the summit, the second one midway between the first and third, while the third is a little posterior to the suture. The junction of the axial ribs and spiral keels renders the spiral keels tubercular. The tubercles on the first cord are oval with their long axis corresponding to the axial sculpture. The tubercles on the median cord are truncated both anteriorly and posteriorly, but sloped a little more gently anteriorly, while the tubercles on the third cord are truncated abruptly posteriorly and gently anteriorly. Suture narrowly channeled. Periphery of the last whorl marked by a deep spiral sulcus, which is as wide as that separating the third from the median cord on the spire. This groove is crossed by the continuations of the axial rib which terminate at its anterior margin. Base moderately long, marked by a strong spiral keel immediately anterior to the peripheral sulcus, and another a little less strong in the middle of the space between the insertion of the columella and this keel. This middle keel is bordered on each side by a deep sulcus. In addition to this, the entire spire and base also bear exceedingly fine spiral striations and incremental lines. Aperture of irregular outline, decidedly channeled anteriorly; posterior angle obtuse; outer lip thick within, thin at the edge where it is rendered sinuous by the external sculpture; columella very stout, almost vertical; inner lip moderately strong, reflected over and adnate to the base; parietal wall covered with a thick callus which renders the peritreme complete.

The type, Cat. No. 204128, U.S.N.M., was collected by the U. S. Bureau of Fisheries steamer *Albatross*, on the shores of Panama Bay. It has six postnuclear whorls and measures—length, 2.9 mm.; diameter 1.0 mm.

CERITHIOPSIS OROVILLENSIS Dickerson.

Cerithiopsis orovillensis DICKERSON, Bull. Dept. Geol. Univ. Cal., vol. 9, No. 17, 1916, p. 489, pl. 39, fig. 7.

The type comes from the Eocene Tejon formation at the University of California locality 2225, south side of Oroville, South Table Mountain. It has nine whorls and measures—length, 6 mm.; diameter, 2 mm.

CERITHIOPSIS (CERITHIOPSIS) DUMBLEI Dickerson.

Cerithiopsis dumblei DICKERSON, Bull. Dept. Geol. Univ. of Cal., vol. 9, No. 17, 1916, p. 489, pl. 38, fig. 12.

The figured type has nine whorls; the specimen measures, length, 9.5 mm.

It was collected in the Eocene Tejon formation at the University of California locality 672, SE. $\frac{1}{4}$ of NW. $\frac{1}{4}$ sec. 24, Parson's Peak, in Tejon white sandstone, 0 to 10 feet below white shale.

CERITHIOPSIS OREGONENSIS Dickerson.

Cerithiopsis oregonensis DICKERSON, Proc. Cal. Acad. Sci., ser. 4, vol. 4, 1914, p. 121, pl. 11, figs. 5, 5a.

The type of this species, No. 246, California Academy of Sciences, comes from the Eocene, locality 25, Roseburg Quadrangle, Oregon, near the center of sec. 19, T. 26 S., R. 3 W., on the east bank of Little River at its confluence with the Umpqua, underneath the bridge at that point. It measures—length, 20 mm.; diameter, 4.5 mm.

CERITHIOPSIS BOLINGERENSIS Clark.

Cerithiopsis bolingerensis CLARK, Bull. Dept. Geol. Univ. Cal., vol. 8, 1915, pp. 490, 491, pl. 65, fig. 25.

This species comes from the Miocene Upper San Pablo of Las Trampas Ridge, University of California locality 1182. It is said to have seven or eight whorls and measures about 8 mm. in length.

CERITHIOPSIS TURNERI Clark.

Cerithiopsis turneri CLARK, Bull. Dept. Geol. Univ. Cal., vol. 8, 1915, p. 490, pl. 65, figs. 1, 2.

This specimen comes from the Miocene, in the Lower San Pablo group at Kirker Pass, University of California locality 100.

The type is said to have 10 to 11 whorls and measures—length, about 15 mm.; diameter, 4 mm.

BITTIUM BARTOLOMENSIS, new species.

Plate 47, fig. 5.

Shell stout, very broadly conic, with deeply channeled suture, the posterior half between the summit and suture of each whorl and the posterior half of the base brown, the rest white. Nuclear whorls decollated. Postnuclear turns marked by broad, rounded axial ribs, of which 16 occur upon the second to fifth, 18 upon the sixth, and 20 upon the last turn. These ribs extend strongly from the rather prominent shoulder at the summit to the suture. The spiral sculpture consists of four equally strong and equally spaced cords, which are about as wide as the spaces that separate them. On the last two turns a slender intercalated spiral thread appears between the second and third and the third and fourth cords. The junction of the axial ribs and spiral cords form quite strong well-rounded tubercles, while the spaces inclosed by them are rather deep concave pits except where they are divided by the intercalated threads. Suture strongly

constricted, channeled. Periphery of the last whorl rendered angulated by a cord, the groove between which and the fourth cord of the spire is crossed by two slender spiral threads. Base short, concave in the middle, marked by seven subequal and subequally spaced low rounded spiral cords, which are about as wide as the spaces that separate them, and numerous very fine axial threads which are best shown in the grooves. Aperture oval, slightly protracted and weakly channeled anteriorly; posterior angle obtuse; outer lip thin, rendered sinuous by the external sculpture; inner lip oblique, slightly curved, reflected over and appressed to the base; parietal wall covered by a thin callus.

The type, Cat. No. 266937, U.S.N.M., was dredged in shallow water in San Bartolome Bay, Lower California. It has $7\frac{1}{2}$ post-nuclear whorls and measures—length, 6.6 mm.; diameter, 2.6 mm.

BITTIUM CHALLISAE, new species.

Plate 47, figs. 2, 6.

Shell very large, white. Nucleus and early postnuclear turns decollated, those remaining slightly shouldered at the summit, weakly rounded in the middle and decidedly contracted immediately above the suture, marked by rather strong, low, well-rounded axial ribs of which 14 occur upon the second and third, 16 upon the fourth to sixth, 18 upon the seventh, and 20 upon the last turn. The spiral sculpture consists of four cords on the early whorls, of which the first, at the summit, is a little weaker than the rest. These primary cords are truncated posteriorly and slope gently anteriorly. Beginning with the fourth whorl an intercalated thread makes its appearance between all the cords and between the summit and the first cord. Suture strongly constricted. Periphery of the last whorl rendered angulated by a cord. Base short, slightly concave, marked by five low, broad, well rounded, obsolete cords which are subequal and subequally spaced. Aperture broadly oval, rather strongly channeled anteriorly; posterior angle obtuse; outer lip thin rendered sinuous at the edge by the external sculpture, showing the external markings within; inner lip somewhat sinuous, rather stout, reflected over and appressed to the base; parietal wall covered by a moderately thick callus.

The type and another specimen, Cat. No. 272376, U.S.N.M., collected by Miss Bertha Challis at San Juan Island, Gulf of Georgia, British Columbia. The type has nine whorls remaining and measures—length, 13 mm.; diameter, 4.2 mm.

BITTIUM SANTAMARIENSIS, new species.

Plate 47, fig. 3.

Shell elongate conic, pale brown. Nuclear whorls decollated. Post-nuclear whorls well rounded, narrowly tabulatedly shouldered at the summit, becoming decidedly contracted between the fourth spiral cord and the suture, marked by narrow, well-rounded, almost vertical axial ribs of which 14 occur upon the first and second, 16 upon the third and fourth, 18 upon the fifth, and 20 upon the last turn. In addition to the axial sculpture, the whorls are marked by four strong spiral cords which are equal and equally spaced, the space between them being as wide as the cords. The first of these cords is at the summit. The junction of these cords and the axial ribs form elongated, well-rounded tubercles, while the spaces between them form rectangular pits, the long axis of which coincides with the spiral sculpture. On the last whorl a slender spiral thread is present in each groove between the raised keels. Periphery marked by a rather strong spiral cord. The space between this and the fourth cord on the spire bears a slender spiral thread. Base moderately long, concave, marked by 8 slender spiral threads which are not quite as broad as the spaces that separate them. Aperture broadly oval, moderately channeled anteriorly; posterior angle obtuse; outer lip thin, rendered sinuous by the spiral sculpture; inner lip oblique, somewhat concave, reflected over and appressed to the base; parietal wall covered by a thin callus.

The type, Cat. No. 268623, U.S.N.M., was collected in shallow water in Santa Maria Bay, Lower California. It has $6\frac{1}{2}$ postnuclear whorls and measures—length, 4.9 m.; diameter, 2 mm.

BITTIUM SANJUANENSIS, new species.

Plate 47, fig. 4.

Shell very large, rather thin, bluish white. Nuclear whorls decollated. Postnuclear whorls almost appressed at the summit, well rounded, decidedly contracted immediately posterior to the suture, marked by strong, broad, heavy, slightly protractive axial ribs which become enfeebled toward the summit and slightly widened there. Of these ribs, 12 occur upon the second and third, 14 upon the fourth and fifth, and 16 upon the last whorl. Intercostal spaces not quite as broad as the ribs. The spiral sculpture consists of five cords, of which the first, which is at the summit, is very slender. The two succeeding this are successively a trifle stronger, while the fourth and fifth are very strong, the last being the heaviest of all. The junction of the axial ribs and the spiral cords form well-rounded, elongated nodules which have their long axis parallel with the spiral

sculpture; the spaces inclosed between them are very shallow, rectangular pits. In addition to the above sculpture the entire surface of the spire and base is marked by many very slender lines of growth and exceedingly fine microscopic spiral striations, the combination of which gives the surface a somewhat cloth-like texture. Suture strongly constricted; it would be channeled were it not for the fact that the peripheral keel makes its appearance above the summit of the whorl, hence removes the strongly channeled element. Periphery of the last whorl marked by strong spiral cord, which is about as far anterior to the fifth cord of the spire as that is separated from the fourth. Base very short, decidedly concave, marked by three slender spiral cords, of which the first is about as far anterior to the periphery as that is distant from the fifth cord on the spire. The other two cords are very slender, the first being at the base of the columella, while the next is a little distance posterior to it. Aperture subquadrate; quite strongly channeled anteriorly; the junction of the outer and basal lip forming almost a right angle; posterior angle obtuse; outer lip very thin, showing the external sculpture within and rendered sinuous by the external sculpture at the edge; inner lip decidedly oblique, slightly curved, slender, reflected and appressed to the base; parietal wall covered by a thin callus.

The type, Cat. No. 168753, U.S.N.M., was collected by Miss Challis off San Juan Island, Gulf of Georgia, British Columbia. It has lost the nuclear turns; $7\frac{1}{2}$ postnuclear whorls remaining measure—length, 11 mm.; diameter, 3.8 mm.

BITTIUM SERRA, new species.

Plate 47, fig. 1.

Shell stout, broadly conic, grayish white. Nuclear whorls decollated. Postnuclear whorls appressed at the summit, strongly rounded, marked by slender, rounded, somewhat retractive axial ribs, of which 18 occur upon the first and second, 20 upon the third, 22 upon the fourth, and 24 upon the remaining turns. In addition to the axial sculpture, the whorls are marked by four spiral cords, of which the first, which is at the summit, is a little weaker than the rest. The junction of these cords with the axial ribs form prominent, strongly rounded tubercles, while the spaces inclosed between them are rounded pits. Suture moderately constricted but not channeled. Periphery of the last whorl rendered angulated by a spiral cord. Base short, slightly concave, marked by four very low, broad, almost equal, spiral cords, which are separated by mere impressed lines. Aperture oval, narrowly, twistedly channeled anteriorly; posterior angle obtuse; outer lip rendered wavy by the external sculpture; inner lip decidedly curved, somewhat revolute, reflected over and appressed to the base; parietal wall covered with a thin callus.

The type, Cat. No. 271076, U.S.N.M., was dredged by the U. S. Bureau of Fisheries steamer *Albatross*, at station 4310, off Point Loma Light, California, in 71 to 75 fathoms, on green mud and fine sand bottom. The type has lost the nucleus and probably the first postnuclear turn; the $6\frac{1}{2}$ remaining measure—length, 6.5 mm.; diameter, 2.6 mm. Cat. No. 268745, U.S.N.M., contains another specimen from San Bartolome Bay, Lower California.

***BITTIUM TRAMPASENSIS* Clark.**

Bittium trampasensis CLARK, Bull. Dept. Geol. Univ. Cal., vol. 8, 1915, pp. 489, 490, pl. 65, figs. 3, 5.

This species occurs in the Miocene, Upper San Pablo group, at University of California locality 118. Two specimens are figured, both incomplete; the measurement given is 8 mm. for the height.

***BITTIUM ? PABLOENSIS* Clark.**

Bittium pabloensis CLARK, Bull. Dept. Geol. Univ. Cal., vol. 8, No. 22, 1915, p. 489, pl. 65, fig. 10.

The unique type came from the Miocene of the San Pablo group of San Pablo Bay. From the description and figure I would unhesitatingly say that this is not a *Bittium*, but I am unwilling to refer it to another group without more evidence. The type is said to have six or seven whorls and to measure—length, about 16 mm.; diameter, 8 mm.

***BITTIUM LONGISSIMUM* Cooper.**

Bittium longissimum COOPER, Bull. 4, Cal. State Min. Bur., 1894, p. 43, pl. 2, fig. 30.

I overlooked this specimen in my paper on The Recent and Fossil Mollusks of the Genus *Bittium* from the West Coast of America.¹

It is a slender specimen of 16 whorls, measuring—length, 12.25 mm.; diameter, 1.55 mm. It was collected by Mr. Watts in the weir at Marysville Buttes. The figure above cited is a wretched one, absolutely unrecognizable. A specimen from the type locality is nicely figured by Dickerson.²

***BITTIUM WASHINGTONIANA* Dickerson.**

Triforis washingtoniana DICKERSON, Cal. Acad. Sci., vol. 5, 1915, p. 63, pl. 6, fig. 13.

This is not a *Triforis*, but a *Bittium*. The No. 362 Cal. Acad. Sci. type has 9 whorls and measures—length, 20 mm.; diameter, 4.5 mm. It comes from the Eocene-Tejon formation locality 183 on the west bank of the Cowlitz River, about one and three-fourths miles southeast of Vadar (Little Falls), Washington.

¹ Proc. U. S. Nat. Mus., vol. 40, 1911, pp. 383-414, pls. 51-58.

² Bull. Dept. Geol. Univ. California, vol. 9, No. 17, 1916, pl. 40, fig. 11.

ALVANIA BARTOLOMENSIS, new species.

Plate 46, fig. 4.

Shell very elongate ovate, pale yellow, slightly mottled and streaked with rust brown. Nuclear whorls $2\frac{1}{2}$, smooth, well rounded. Postnuclear whorls well rounded, appressed at the summit, marked by incised spiral lines which are of somewhat irregular strength and spacing. Of these lines 17 occur between the summit and the periphery of the last whorl. The axial sculpture is reduced to mere lines of growth. Suture moderately constricted, periphery of the last whorl well rounded. Base moderately long, well rounded, marked by incised spiral lines which are of equal strength and spacing. Aperture irregular, decidedly effuse at the junction of the outer and basal lip; slightly channeled anteriorly; posterior angle acute; outer lip thin at the edge, thick within. Inner lip short, thick, slightly curved, reflected over and appressed to the somewhat attenuated base; parietal wall covered with a thick callus, which renders the peritreme complete.

The type, Cat. 268742, U.S.N.M., was collected by the United States Bureau of Fisheries steamer *Albatross*, in shallow water in San Bartolome Bay, Lower California. It has $4\frac{1}{2}$ postnuclear whorls and measures—length, 4.2 mm.; diameter, 1.9 mm.

ALVANIA KYSKAENSIS, new species.

Plate 46, fig. 6.

Shell elongate ovate, pale brownish yellow. Nuclear whorls one and one-half, well rounded, marked by very slender spiral striations and exceedingly fine incremental lines. Postnuclear whorls strongly rounded, weakly shouldered at the summit, marked by slender axial riblets which are somewhat sinuous and slightly retractorily slanting. Of these ribs 24 occur upon the first, 26 upon the second, and 40 upon the penultimate turn; these are about one-third as wide as the spaces that separate them. In addition to the axial sculpture, the whorls are marked by four spiral cords, of which the first, which is about as far from the summit as it is distant from the second, is very weak on the first two whorls, but on the last assumes almost the strength of the other three cords. The other three cords are of equal strength and spacing. The junction of the axial ribs and the spiral cords, which are a little stronger than the ribs, form weak nodules, while the spaces inclosed between them appear as well impressed, squarish pits. In addition to this sculpture, the entire surface is marked by very fine incremental lines and numerous microscopic spiral striations, the two lending it a cloth-like texture. Suture strongly constricted. On the last whorl the first basal keel makes its appearance above the summit of the succeeding turn. Periphery of the last whorl marked by a spiral sulcus about as wide as those separating the cords on the spire. Base well rounded, marked by seven equal

and equally spaced low, well-rounded spiral cords, which are a little wider than the spaces that separate them. Aperture subcircular; posterior angle obtuse; outer lip strongly curved, rendered somewhat sinuous by the external sculpture; inner lip strongly curved; parietal wall covered by a thick callus which renders the peritreme almost complete.

The type and three specimens of this species, Cat. No. 271407, U.S.N.M., were collected by Dr. William H. Dall in shallow water at Kyska Harbor, Aleutian Islands, Alaska. The type has $3\frac{1}{2}$ post-nuclear whorls and measures—length, 2.5 mm.; diameter, 1.2 mm.

ALVANIA DINORA, new species.

Plate 46, fig. 5.

Shell small, elongate ovate, yellowish white. Nuclear whorls two, strongly rounded, smooth. Postnuclear whorls strongly rounded, almost appressed at the summit and moderately constricted at the suture, marked by 7 very low, flattened spiral cords between the sutures, which are separated by a shallow impressed line. The axial sculpture consists of numerous very slender threads which are almost vertical. Suture strongly constricted. Periphery of the last whorl somewhat inflated, well rounded, base moderately long, slightly attenuated anteriorly, marked by 6 low, ill-defined rounded spiral cords, which, like those on the spire, are separated by mere impressed lines. The axial ribs also continue over the base. Aperture broadly oval, decidedly effuse at the junction of the basal and the outer lip; posterior angle obtuse; outer lip thick within, thin at the edge, evenly curved from the posterior angle to its junction with the inner lip; inner lip decidedly curved, somewhat reflected and appressed to the base; parietal wall covered by a thick callus, which practically renders the peritreme complete.

The type, Cat. No. 268730, U.S.N.M., and three additional specimens of this species, were collected by Mr. Willis at Forrester Island, Alaska. The type has a little more than 3 postnuclear whorls and measures—length, 2 mm.; diameter, 1 mm.

This is a very small species with very feeble sculpture.

In addition to these new species of *Alvania*, we have seen the additional specimens listed under the species mentioned below since the publication of my little monograph on The Recent and Fossil Mollusks of the Genus *Alvania* from the West Coast of America.¹

It may be well to mention here that recent studies in the classification of the group will make it necessary to redistribute the members which we have brought together under the genus *Alvania* among several groups. I refrain from doing this at this time, because I wish first to examine the type-species of all the supraspecific groups before giving a final opinion.

¹Proc. U. S. Nat. Mus., vol. 41, pp. 333-362, pla. 29-32.

ALVANIA COSMIA Bartsch.

Five specimens, Cat. No. 271497, U.S.N.M., from Todos Santos Bay, California.

ALVANIA ACUTILIRATA Carpenter.

Five specimens, Cat. No. 268741, U.S.N.M., from San Diego, California.

ALVANIA AEQUISCULPTA Keop.

Eleven specimens, Cat. No. 253089, U.S.N.M., from Pacific Beach, California.

ALVANIA COMPACTA Carpenter.

Two specimens, Cat. No. 271002, U.S.N.M., from Netarts Bay, Oregon. Fifteen specimens, Cat. No. 268743, U.S.N.M., from Yakutat Bay, Alaska.

Of *Rissoina* we have seen additional specimens of the following five species:

RISSOINA KELSEYI Dall and Bartsch.

One specimen, Cat. No. 271651, U.S.N.M., from San Diego, California.

RISSOINA HISTIA Bartsch.

One specimen, Cat. No. 211678, U.S.N.M., from La Paz, Gulf of California.

RISSOINA DALLI Bartsch.

One specimen, Cat. No. 268737, U.S.N.M., from San Pedro, California.

RISSOINA NEREINA Bartsch.

One specimen, Cat. No. 268643, U.S.N.M., from San Bartolome Bay, Lower California.

One specimen, Cat. No. 267735, U.S.N.M., from Santa Maria Bay, Lower California.

EXPLANATION OF PLATES.

PLATE 42.

- FIG. 1. *Pyramidella* (*Pharcidella*) *magdalenensis*, new species.
2. *Turbonilla* (*Pyrgolampros*) *franciscana*, new species.
3. *Pyramidellida* (*Longchaeus*) *cooperi* Anderson and Martin.
4. *Turbonilla* (*Strioturbonilla*) *redondoensis*, new species.
5. *Odostomia* (*Evalea*) *pleioregona*, new species.
6. *Turbonilla* (*Pyrgiscus*) *ista*, new species.
7. *Turbonilla* (*Pyrgiscus*) *cortez*, new species.
8. *Turbonilla* (*Strioturbonilla*) *barkleyensis*, new species.
9. *Turbonilla* (*Mormula*) *sebastiani*, new species.
10. *Turbonilla* (*Pyrgiscus*) *dora*, new species.

PLATE 43.

- FIG. 1. *Turbonilla* (*Pyrgiscus*) *lamna*, new species.
2. *Odostomia* (*Evalea*) *orfordensis*, new species.
3. *Turbonilla* (*Mormula*) *viscainoi*, new species.
4. *Turbonilla* (*Pyrgiscus*) *ulloa*, new species.
5. *Turbonilla* (*Ugarteia*) *juani*, new species.
6. *Odostomia* (*Evalea*) *willeiti*, new species.
7. *Turbonilla* (*Pyrgolampros*) *hannibali*, new species.
8. *Turbonilla* (*Strioturbonilla*) *schmitti*, new species.

PLATE 44.

- FIG. 1. *Turbonilla* (*Strioturbonilla*) *montezuma*, new species.
2. *Turbonilla* (*Strioturbonilla*) *santamariana*, new species.
3. *Turbonilla* (*Strioturbonilla*) *doredona*, new species.
4. *Turbonilla* (*Pyrgolampros*) *pugtensis*, new species.
5. *Turbonilla* (*Pyrgisculus*) *guilleni*, new species.
6. *Turbonilla* (*Pyrgiscus*) *eva*, new species.
7. *Turbonilla* (*Pyrgolampros*) *tremperi*, new species.
8. *Turbonilla* (*Pyrgolampros*) *hemphilli*, new species.
9. *Turbonilla* (*Strioturbonilla*) *barkleyensis*, new species.
10. *Turbonilla* (*Pyrgiscus*) *ina*, new species.
11. *Turbonilla* (*Strioturbonilla*) *canadensis*, new species.

PLATE 45.

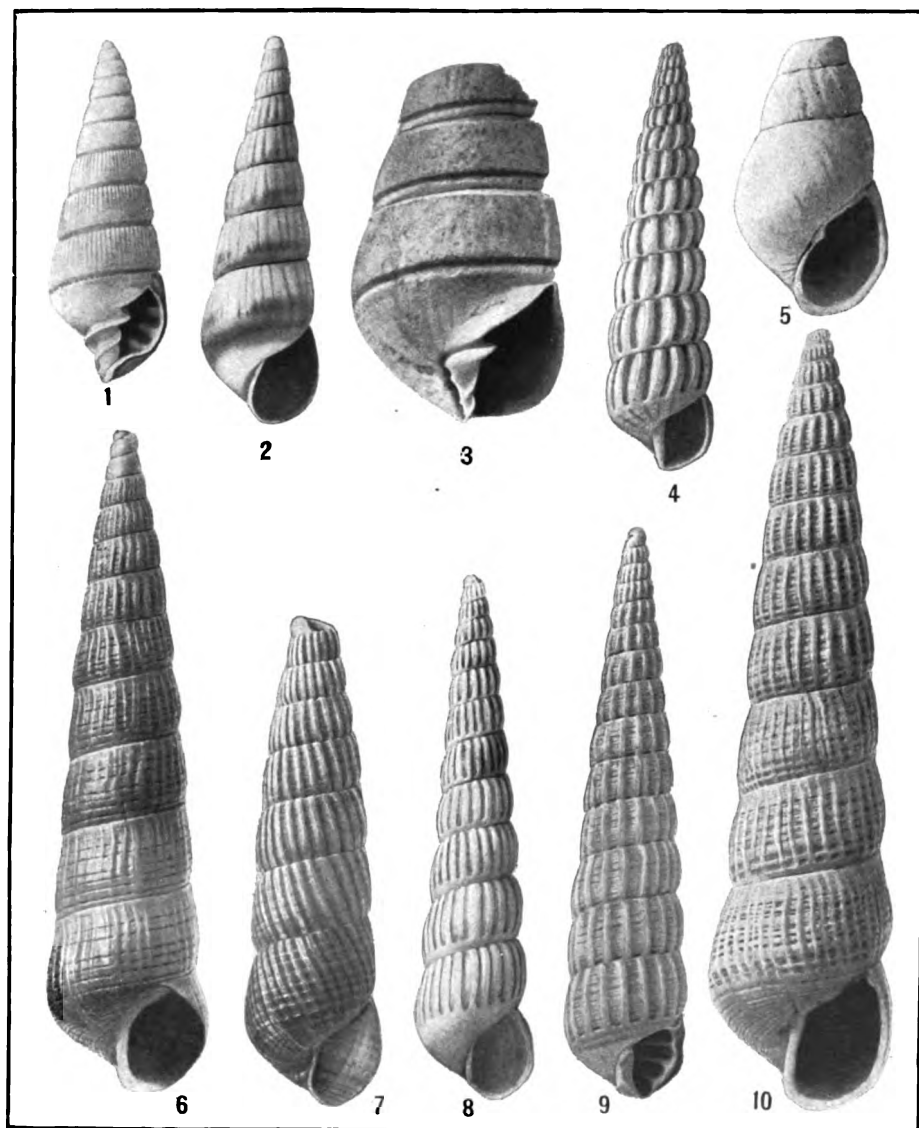
- FIG. 1. *Turbonilla* (*Cingulina*) *urdeneta*, new species.
2. *Turbonilla* (*Pyrgiscus*) *baegerti*, new species.
3. *Turbonilla* (*Pyrgiscus*) *cabrilloi*, new species.
4. *Turbonilla* (*Pyrgiscus*) *tecalco*, new species.
5. *Turbonilla* (*Pyrgiscus*) *bartolomensis*, new species.
6. *Odostomia* (*Evalea*) *pleioregona*, new species.
7. *Odostomia* (*Evalea*) *franciscana*, new species.
8. *Turbonilla* (*Pyrgiscus*) *corsoensis*, new species.
9. *Turbonilla* (*Pyrgiscus*) *mariana*, new species.
10. *Turbonilla* (*Pyrgiscus*) *almcjasensis*, new species.
11. *Turbonilla* (*Pyrgiscus*) *lazaroensis*, new species.
12. *Turbonilla* (*Pyrgiscus*) *cortez*, new species.

PLATE 46.

- FIG. 1. *Odostomia (Chrysallida) santamariensis*, new species.
2. *Cerithiopsis (Cerithiopsis) helena*, new species.
3. *Odostomia (Chrysallida) taravali*, new species.
4. *Alvania bartolomensis*, new species.
5. *Alvania dinora*, new species.
6. *Alvania kyskaensis*, new species.
7. *Odostomia (Evalea) valeroi*, new species.
8. *Odostomia (Odostomia) orcutti*, new species.
9. *Cerithiopsis (Cerithiopsis) charlottensis*, new species.
10. *Cerithiopsis (Cerithiopsis) bakeri*, new species.
11. *Cerithiopsis (Cerithiopsis) charlottensis*, new species.
12. *Cerithiopsis (Cerithiopsis) grippi*, new species.

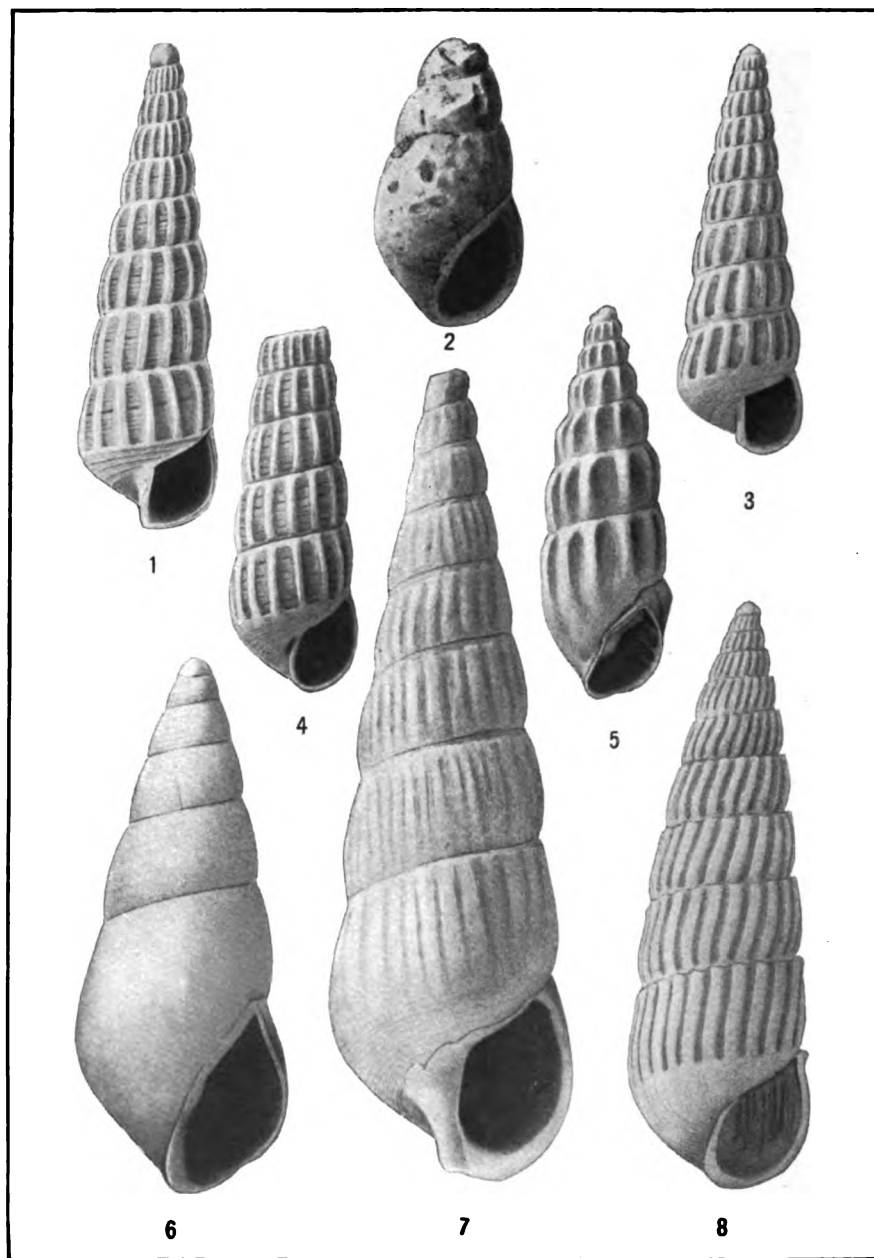
PLATE 47.

- FIG. 1. *Bittium serra*, new species.
2. *Bittium challisae*, new species.
3. *Bittium santamariensis*, new species.
4. *Bittium sanjuanensis*, new species.
5. *Bittium bartolomensis*, new species.
6. *Bittium challisae*, new species.



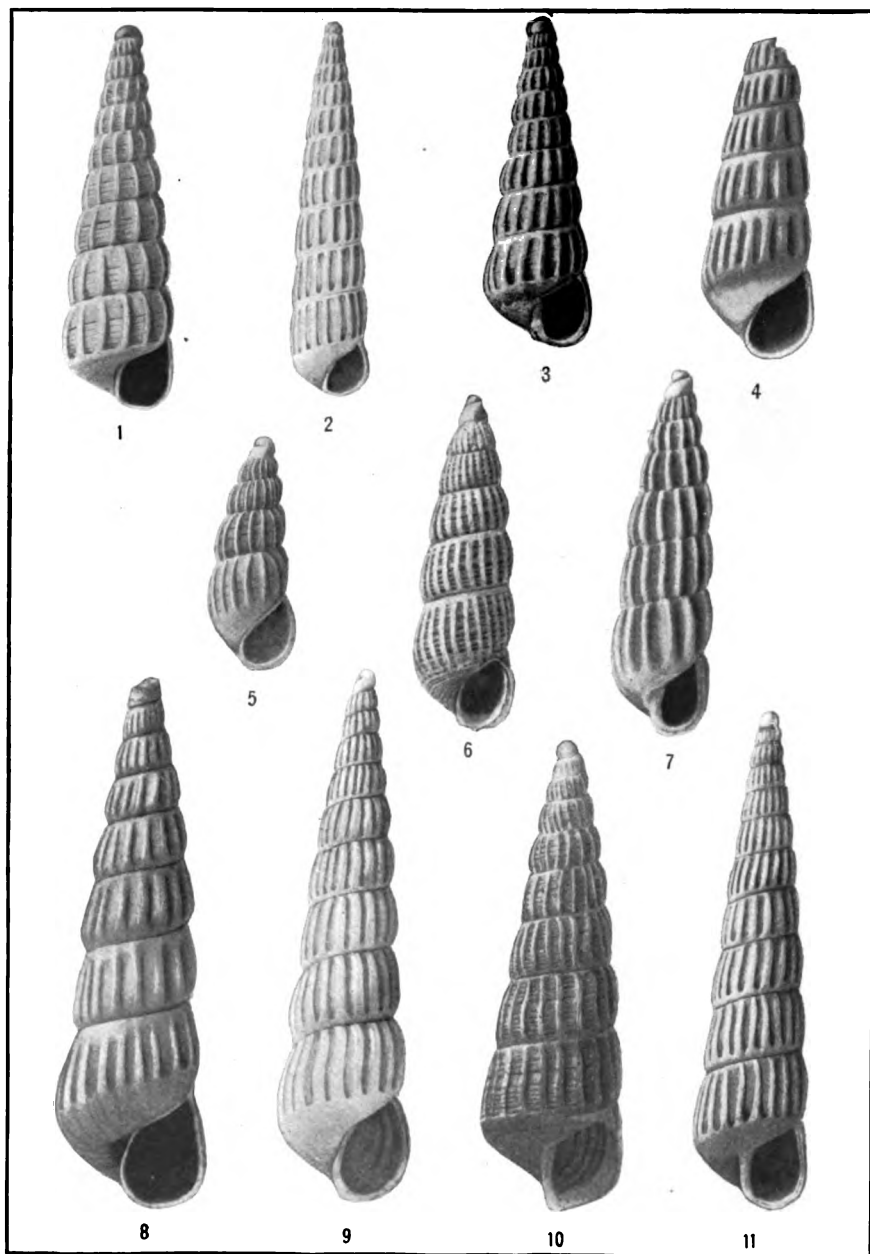
WEST AMERICAN MARINE MOLLUSKS.

FOR EXPLANATION OF PLATE SEE PAGE 680.



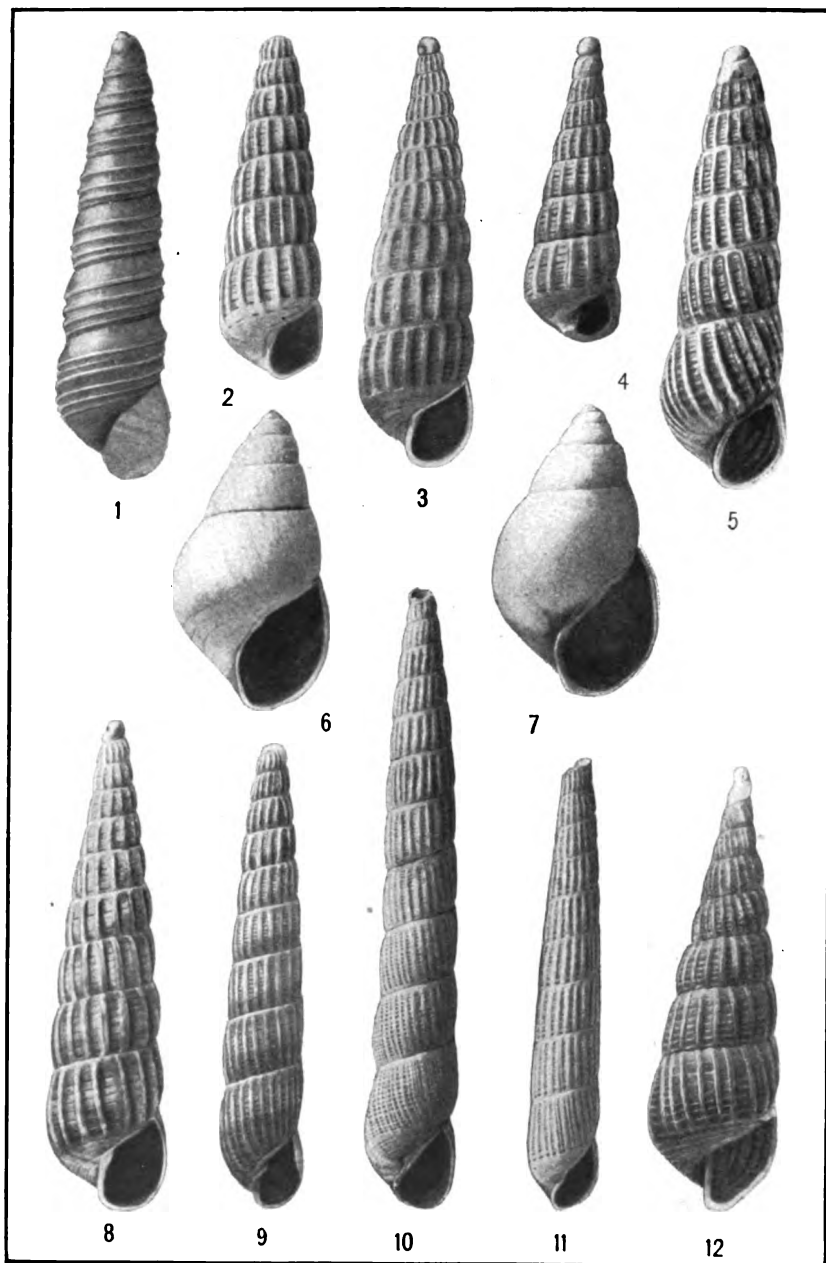
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FOR EXPLANATION OF PLATE SEE PAGE 680.



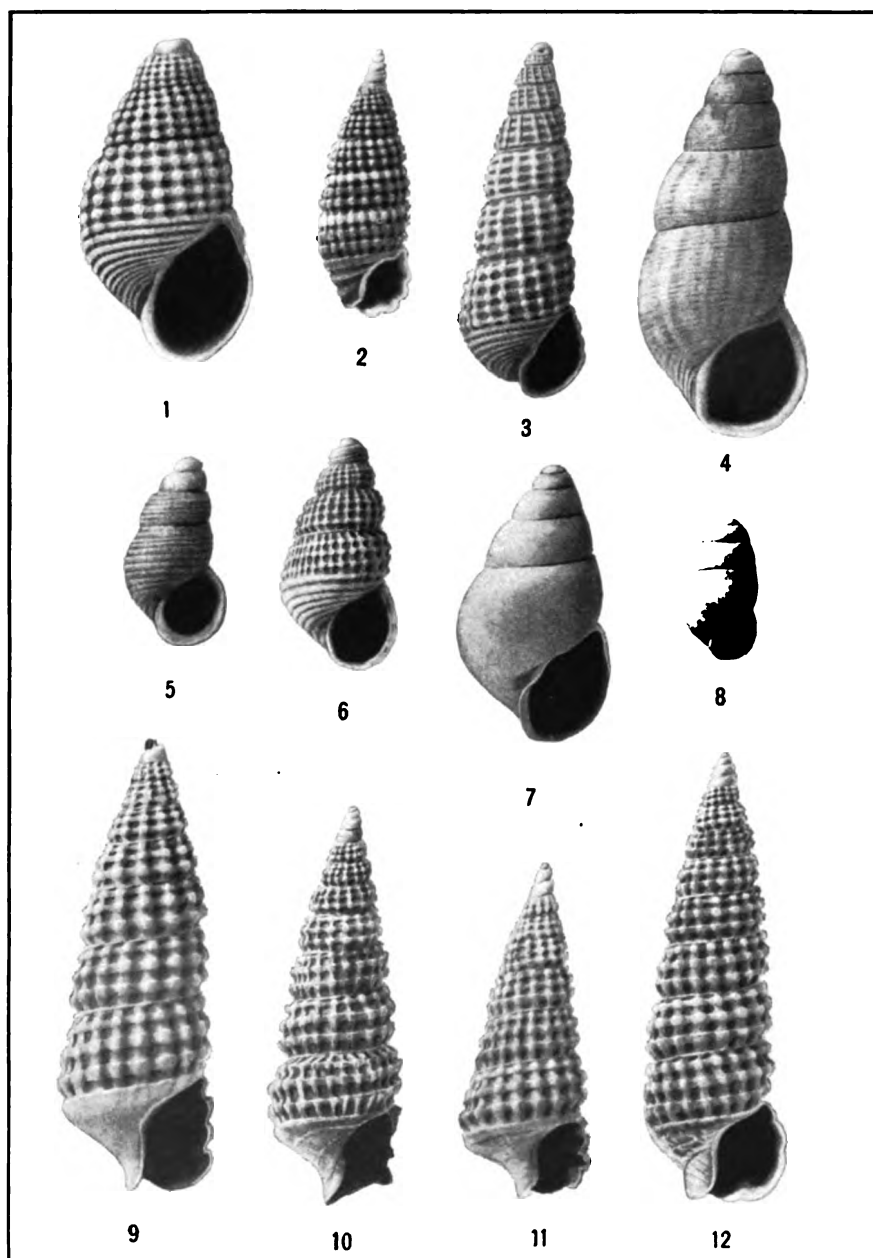
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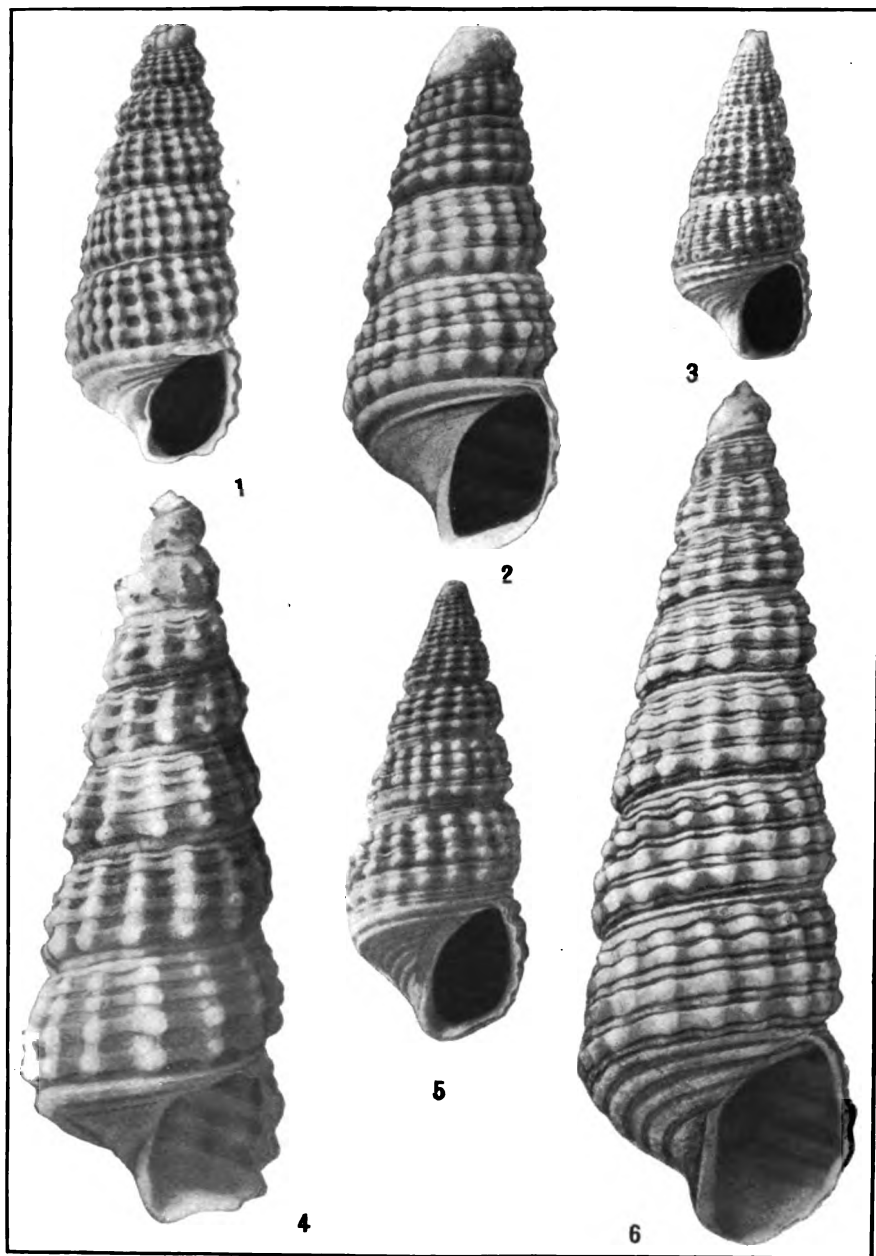
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WEST AMERICAN MARINE MOLLUSKS.

FOR EXPLANATION OF PLATE SEE PAGE 681.



WEST AMERICAN MARINE MOLLUSKS.

FOR EXPLANATION OF PLATE SEE PAGE 681.

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INDEX.

	Page.		Page.
Abbott, Dr. W. L., mammals collected by, from islands off Sumatra.....	437	Allurus neapolitanus.....	162
Acanthagrion gracile.....	499	ninnii.....	162
Acondylacanthus occidentalis.....	261	pupa.....	163
Acreotrichites.....	376	tetraedrus.....	161
scopulicornis.....	376	Alvania acutiflora.....	679
Acreotrichus atratus.....	377	aequisculpta.....	679
gibbicornis.....	377	bartolomensis.....	677
Acrydium (Tettix) arenosum angustum.....	207	compacta.....	679
Aeolothrips brodiei.....	381	cosmia.....	679
Aeshna californica.....	594, 596, 598, 600	dinora.....	678
constricta.....	622	kyskaensis.....	677
interrupta.....	581	Amblycorypha floridana carinata.....	202, 225
interna.....	581, 622	oblongifolia.....	225
nevadensis.....	581,	occidentalis.....	201, 202, 209
610, 612, 613, 614, 615, 634		uhleri.....	202, 225
multicolor.....	582,	Amelurus catus.....	293
594, 596, 599, 600, 601, 602, 603, 605, 607,		primaevus.....	293
608, 610, 618, 622, 623, 625, 626, 627, 629, 630		Ammophila arenaria.....	218
palmata.....	582,	Amphiagrion sauchum abbreviatum.....	609,
595, 610, 612, 613, 616, 617, 620, 622, 625		612, 617, 630, 633	
walkerii.....	516, 517, 574, 587, 588, 595, 632	Amyzon brevipinne.....	292
Agathis exoratus.....	321	Anatis resurgens.....	463, 465
haematodes.....	338, 341	Anax junius.....	582, 584, 594, 596,
liberator.....	326	599, 603, 607, 610, 612, 622, 625, 626, 627, 629, 633	
meabilis.....	338, 341	Anaxipha exigua.....	202, 224
media.....	321	Anisodonta(?) pellucida.....	411
senilrubra.....	326	Annelid, polychaetous, a new species of, from Panama.....	427
vulgaris.....	321	Anomalagrion hastatum.....	496
Agriion acquabile.....	494	Anthomyia atavella.....	381
californicum.....	484	persepulta.....	350
exclamationis.....	480	Anthreptes malacensis bawcanus.....	196
Allobophora (Bimastus) constricta.....	176	malacensis.....	196, 197
gieseleri.....	171	Anuraea aculeata.....	475
palustris.....	169	cochlearis.....	475
parva.....	173	Anurogryllus muticus.....	202, 223
tumida.....	170	Apis rostrata.....	75
caliginosa.....	166	Apithes agitator.....	234
chlorotica.....	167	Archaeobatis gigas.....	258
constricta.....	176	Archilestes californica.....	593, 596
gieseleri.....	171	Arctictis niasensis.....	443, 458
longa.....	167	Ardea sumatrana.....	184
lomberti.....	164	Argia agrioides.....	596, 603, 607, 630
mucosa.....	165	emma.....	597, 601, 603
ninnii.....	162	vivida.....	516, 562,
norvegica.....	176	557, 596, 597, 598, 603, 608, 613, 614, 630, 631, 633	
octaedra.....	168	Arphia sulphurea.....	201, 212
parva.....	173	xanthoptera.....	202, 213
riparia.....	167	Aspidorhynchus acutirostris.....	285
rosea.....	165	tenuirostris.....	286
subrubicunda.....	168	Asplanchna brightwellii.....	477
forma hortensis.....	166	pridonta.....	477
tenuis.....	176	Asplanchnopus multiceps.....	477
terrestris.....	167	Asterolepis ornata.....	238
tumida.....	170	Astraspis desiderata.....	238
turgida.....	166	Atlanticus americanus.....	202, 223
Allurus hercynius.....	162	davisi.....	201, 223

	Page.		Page.
<i>Atlanticius testaceus</i>	232	<i>Bembix rostrata</i>	125, 126
<i>Baris matura</i>	472	<i>rugosa</i>	95
<i>primalis</i>	463, 471	<i>sayi</i>	90
Bartsch, Paul. Descriptions of new West		<i>similans</i>	103
American marine mollusks and notes on		<i>spinolae</i>	125, 127, 128, 129, 130, 139
previously described forms.....	637	<i>stenobdoma</i>	94
Bawean Island, Java Sea, birds of.....	183	<i>texana</i>	111
Beetles, fossil, new species of, from Florissant,		<i>troglydotes</i>	108
Colorado.....	463	<i>u-scripta</i>	83
<i>Bellonota scutellaris</i>	467	<i>Bembyx cameroni</i>	99
<i>Belonorhynchus gracilis</i>	281	<i>obsoleta</i>	105
<i>gigas</i>	281	<i>Biblio gurnetensis</i>	375
<i>Belonostomus tenuirostris</i>	286	<i>obligocenus</i>	375
<i>Bembecae aberantes</i>	117	<i>wickhami</i>	374
<i>Bembex amoena</i>	88	<i>Bicyrtes annulata</i>	67
<i>argentifrons</i>	119	<i>burmeisteri</i>	62
<i>belfragei</i>	92, 95	<i>capnoptera</i>	72
<i>carolina</i>	20	<i>fodiens</i>	60
<i>ciliata</i>	119	<i>gracilis</i>	68
<i>cinerea</i>	84	<i>insidiatrix</i>	71
<i>connexa</i>	115	<i>mesillensis</i>	73
<i>crassonis</i>	92	<i>parata</i>	64
<i>fasciata</i>	98	<i>quadrifasciata</i>	65, 134
<i>insignis</i>	92	<i>servillii</i>	59, 62
<i>longirostra</i>	5	<i>ventralis</i>	62, 132
<i>monodonta</i>	119	<i>viduata</i>	69
<i>obsoleta</i>	105	<i>Bimastos palustris</i>	169
<i>occidentalis</i>	106	Birds of Bawean Island, Java Sea.....	183
<i>primaestata</i>	101	<i>Bittium bartolemensis</i>	672
<i>pruinosa</i>	104	<i>challissae</i>	673
<i>sayi</i>	90, 96	<i>longissimum</i>	676
<i>similans</i>	103	<i>pabloensis</i>	676
<i>spinolae</i>	98	<i>sanjuanensis</i>	674
<i>texana</i>	111	<i>santamariensis</i>	674
<i>vespiformis</i>	18	<i>serra</i>	675
<i>Bembicine wasps of America north of Mexico,</i>		<i>trampasensis</i>	676
a revision of the.....	1	<i>washingtoniana</i>	676
<i>Bembidula burmeister</i>	62	<i>Bixiura lobata</i>	479, 482
<i>capnoptera</i>	72	<i>Bothriolepis coloradensis</i>	240
<i>var. mesillensis</i>	73	<i>nitida</i>	240
<i>fodiens</i>	60	<i>Brachionus angularis</i>	474
<i>insidiatrix</i>	71	<i>caudatus</i>	474
<i>melloti</i>	64	<i>calyciflorus</i>	474
<i>mesillensis</i>	73	<i>capsuliflorus</i>	474
<i>parata</i>	64	<i>militaris</i>	475
<i>pictifrons</i>	134	<i>mulleri</i>	475
<i>quadrifasciata</i>	65	<i>pala</i>	474
<i>variegata</i>	65, 67	<i>patulus</i>	474
<i>ventralis</i>	59	<i>plicatilis</i>	475
<i>viduata</i>	69	<i>urocolearis</i>	475
<i>Bembix amoena</i>	88	<i>variabilis</i>	475
<i>arcuata</i>	81	<i>Brachypodius baweanus</i>	192
<i>belfragei</i>	92, 131, 132	<i>Brachyspathus curiosus</i>	463, 466
<i>beutenmulleri</i>	86, 105	<i>Bracon</i> , monograph of the Nearctic hymen-	
<i>cameroni</i>	99	optera of the genus.....	305
<i>cinerea</i>	84	<i>ashmeadi</i>	329
<i>comata</i>	100	<i>californicus</i>	331
<i>connexa</i>	115	<i>comstocki</i>	323
<i>foxi</i>	96	<i>hematodes</i>	338
<i>hellanthopolis</i>	113	<i>kelloggi</i>	327
<i>hinei</i>	86	<i>melanoptera</i>	336
<i>latifrons</i>	116	<i>minutator</i>	307
<i>melanaspis</i>	109	<i>montrealensis</i>	326
<i>nubilipennis</i>	87, 139	<i>nigrosternum</i>	332
<i>occidentalis</i>	106	<i>slossonae</i>	318
<i>primaestata</i>	101	<i>szepligetii</i>	334
<i>pruinosa</i>	104	<i>virginiensis</i>	341

	Page.		Page.
<i>Bracon vulgaris</i>	308, 321	<i>Collotheca ornata</i>	477
<i>Brechmorhoga mendax</i>	605, 627	<i>Columba tigrina</i>	188
<i>Bruchus antaeus</i>	463, 469	<i>Colurella obtusa</i>	476
<i>bowditchi</i>	469	<i>uncinata</i>	477
<i>Butorides javanicus javanicus</i>	184	<i>Conocephalus brevipennis</i>	201, 202, 231
<i>virescens</i>	184	<i>fasciatus</i>	201, 230
California, central, and Nevada, notes on the		<i>memoralis</i>	231
life history and ecology of the dragonflies of.	493	<i>nigropleuroides</i>	202, 232
<i>Callidium aereum</i>	469	<i>saltans</i>	202, 232
<i>grandaevum</i>	463, 469	<i>spartinae</i>	202, 232
<i>Calyptrigena elongata</i>	408	<i>stictomerus</i>	202, 232
<i>Camnula pellucida</i>	201, 215	<i>strictus</i>	202, 231
<i>Camptonotus carolinensis</i>	233	<i>Copeus pachyurus</i>	474
<i>Campylostoma matutiforme</i>	390	<i>Corbula kelseyi</i>	416
<i>plerense</i>	399	<i>porcella</i>	415
<i>Carcharops wortheni</i>	256	<i>Cordulegaster annulatus</i>	515
<i>Cardiomya balboae</i>	407	<i>diadema</i>	518
<i>Cardium dulcinea</i>	412	<i>dorsalis</i>	515, 516, 574, 576, 594, 595, 597, 599, 608, 610, 631, 632
<i>Cathypna curvicornis</i>	476	<i>maculatus</i>	521
<i>hornemannii</i>	476	<i>Cordulia shurtleffi</i>	615, 634
<i>Catopterus gracilis</i>	280	<i>Coryphodon simus</i>	432
<i>Celaenura</i>	495	Crabs, cretaceous, new species of, from South Dakota.....	385
<i>denticollis</i>	496, 500, 594, 596, 599, 600, 601, 602, 603, 622, 624, 627, 629, 631	<i>Cratacanthus dubius</i>	464
<i>gemina</i>	497, 594, 596	<i>florissantensis</i>	463, 464
<i>Cephalodella catellina</i>	474	<i>Cremnops haematodes</i>	338, 341
<i>loricula</i>	474	<i>melanoptera</i>	336
<i>Cerapsis carinata</i>	242	<i>semirubra</i>	326
<i>Ceratura capreola</i>	496	<i>vulgaris</i>	321
<i>Ceriodaphnia longispina</i>	475	<i>Crenella columbiana</i>	396
<i>Cerithiopsis bolingerensis</i>	672	<i>rotundata</i>	406
(<i>Cerithiopsis</i>) <i>bakeri</i>	670	<i>Cryptocercus punctulatus</i>	206
<i>charlottensis</i>	668	<i>Ctenacanthus acutus</i>	262
<i>dumblei</i>	671	<i>angulatus</i>	262
<i>grippi</i>	669	<i>burlingtonensis</i>	262
<i>helena</i>	670	<i>canaliculatus</i>	262
<i>dumblei</i>	671	<i>coelatus</i>	262
<i>oregonensis</i>	672	<i>coxianus</i>	262
<i>orovillensis</i>	671	<i>cylindricus</i>	262
<i>turneri</i>	672	<i>decussatus</i>	261, 262
<i>Cervulus moschatus</i>	458	<i>deflexus</i>	262
<i>Cetoconcha malespinae</i>	407	<i>depressus</i>	262
<i>Ceyx rufidorsus innominatus</i>	184	<i>excavatus</i>	262
<i>Chalcophaps indica</i>	184	<i>gemmatus</i>	262
<i>Cheirodus orbicularis</i>	276	<i>gracillimus</i>	261
<i>Cheirolepis canadensis</i>	273	<i>gradocostatus</i>	262
<i>Chiropodomys niadis</i>	458	<i>gurleyi</i>	262
<i>Chloealtis conspersa</i>	201, 203, 212	<i>harrisoni</i>	262
<i>Chorthippus curtispennis</i>	201, 212	<i>keokuk</i>	262
<i>Chorthippa viridifasciata</i>	201, 214	<i>littoni</i>	262
<i>Cimyris ornata ornata</i>	197	<i>longinodosus</i>	261, 262
<i>ornatus</i>	197	<i>luasi</i>	261, 262
<i>Cladodus aculeatus</i>	255	<i>pellensis</i>	262
<i>compressus</i>	256	<i>sculptus</i>	262
<i>spinosus</i>	254	<i>semicostatus</i>	262
<i>striatus</i>	256	<i>similis</i>	262
<i>Climocephalus elegans</i>	202, 211	<i>solidus</i>	261, 262
<i>Coccinella sodoma</i>	466	<i>spectabilis</i>	261, 262
<i>Cochliodius occidentalis</i>	260	<i>varians</i>	262
Cockrell, T. D. A. New Tertiary insects.....	373	<i>venustus</i>	261, 262
<i>Coelacanthus elegans</i>	271	<i>xiphias</i>	262
<i>exiguus</i>	271	<i>Ctenodus serratus</i>	248
<i>ornatus</i>	271	<i>Cuculus canorus telephonus</i>	188
<i>Coenagrion resolutum</i>	609, 613, 615	<i>telephonus</i>	188
<i>Collotheca cornuta</i>	477	<i>Cuspidaria apodema</i>	407
<i>coronetta</i>	477	<i>obesa</i>	407

	Page.		Page.
<i>Cynopterus</i> babi.....	438, 457	<i>Edestus</i> heinrichi.....	269
<i>brachyotis</i>	439, 459, 460	<i>Eisenia</i> carolinensis.....	164
<i>major</i>	458	<i>foetida</i>	165
<i>minutus</i>	458	<i>lönnerbergi</i>	164
<i>princeps</i>	3, 458	<i>rosea</i>	165
<i>schzereri</i>	438	<i>veneta</i> , var. <i>hortensis</i>	166
<i>tithaechellus</i>	438	<i>Eiseniella</i> tetraedra.....	161
<i>Dacrydium</i> pacificum.....	405	<i>hercynia</i>	162
Dakota, South, new species of cretaceous		<i>neapolitana</i>	162
crabs from.....	385	<i>ninnii</i>	162
<i>Dakoticancer</i>	385	<i>pupa</i>	163
<i>overana</i>	386	<i>Elonichthys</i> hypolepis.....	274
Dall, William Healey. Diagnoses of new		<i>peltigerus</i>	274
species of marine bivalve mollusks from the		<i>hypolepis</i>	274
northwest coast of America in the collection		<i>perpennatus</i>	275
of the United States National Museum....	393	<i>Emballonura</i> monticola.....	457, 458, 459, 460
<i>Dapendoglossus</i> testis.....	288	<i>Enallagma</i> anna.....	610, 621
<i>Daphnia</i> longispina.....	475	<i>calverti</i>	504, 609, 612, 621, 633
<i>Deltodus</i> occidentalis.....	260	<i>carunculatum</i>	594,
<i>Dendrobaena</i> boeckii.....	168	596, 597, 599, 600, 601, 602, 603, 605,	
<i>Dendrotettix</i> australis.....	220	606, 608, 609, 610, 612, 618, 619, 620,	
<i>Dermatomya</i> beringiana.....	406	622, 623, 624, 625, 627, 629, 631	
<i>buttoni</i>	406	<i>civile</i>	499
<i>leonina</i>	406	<i>clausum</i>	619, 622
<i>Diaschiza</i> auriculata.....	474	<i>cyathigerum</i>	562, 594, 596, 597, 599, 600,
<i>forficata</i>	474	603, 605, 606, 612, 613, 615, 629, 630, 633	
<i>gibba</i>	474	<i>praeparum</i>	594, 596, 597
<i>globata</i>	474	<i>Encentrum</i> fells.....	474
<i>gracilis</i>	474	<i>Encoptolophus</i> sordidus.....	201, 215
<i>hoodii</i>	474	<i>Enterion</i> caliginosum.....	166
<i>tenuior</i>	474	<i>castaneum</i>	179
<i>Dicaeum</i> flammeum.....	198	<i>fetidum</i>	165
<i>Dichromorpha</i> viridis.....	202, 203, 211	<i>herculeum</i>	180
<i>Dicranophorus</i> forcipatus.....	474	<i>octaedrum</i>	168
<i>Dicrenodus</i> texanus.....	256	<i>roseum</i>	165
<i>Diglena</i> catellina.....	474	<i>terrestris</i>	167
<i>Dinichthys</i>	248	<i>tetraedrum</i>	161
<i>missouriensis</i>	248	<i>Eosiphora</i> najas.....	474
<i>terrelli</i>	248	<i>Epimys</i> fremensis fremensis.....	451
<i>tuberculatus</i>	249	<i>Epiphanes</i> senta.....	474
<i>Dinocharis</i> collinsii.....	477	<i>Erismacanthus</i> formosus.....	265
<i>pocillum</i>	477	<i>maccoyanus</i>	265
<i>tetractis</i>	477	<i>Erismatura</i> jamalensis (Gmelin) on certain	
<i>Diosphyus</i> vulgaris.....	321	secondary sexual characters in	
<i>Dipsacaster</i> anopius.....	367	the male ruddy duck.....	479
<i>Dipterus</i> angustus.....	247	<i>australis</i>	452
<i>digitatus</i>	246	<i>ferruginea</i>	482
<i>mordax</i>	246	<i>jamalensis</i>	479
<i>pectinatus</i>	246	<i>leucocephala</i>	482
<i>Disosteira</i> carolina.....	201, 217	<i>vittata</i>	482
<i>Distyla</i> spinifera.....	477	<i>Eritettix</i> simplex.....	208
<i>Diurella</i> brachyura.....	477	<i>Erpetogomphus</i> compositus.....	603, 618, 620, 624, 626
<i>tenuior</i>	477	<i>Erycina</i> bakeri.....	409
<i>tigris</i>	477	<i>balliana</i>	409
<i>weberi</i>	477	<i>catalinae</i>	409
<i>Doru</i> aculeatum.....	202, 206	<i>chacel</i>	409
Dragonflies of central California and Nevada,		<i>coronata</i>	409
notes on the life history and ecology of the.	483	<i>santarosae</i>	410
<i>Drepanacanthus</i> gemmatus.....	263	<i>Ervilia</i> californica.....	414
Duck, male ruddy, on certain secondary		<i>Erythemis</i> simplicicollis.....	595, 597, 600, 601, 602,
sexual characters in the, <i>Erismatura</i> jamal-		604, 607, 623, 624, 626, 628, 631	
censis (Gmelin).....	479	<i>Euchlanis</i> deflexa.....	475
Earthworms, North American, of the family		<i>dilatata</i>	475
Lumbricidae in the collections of the United		<i>lyra</i>	475
States National Museum.....	157	<i>plicata</i>	475
Eastman, Charles R. Fossil fishes in the col-		<i>pyriformis</i>	475
lection of the United States National Mu-		<i>triquetra</i>	475
seum.....	235	<i>Eudynamys</i> honorata.....	184

	Page.		Page.
<i>Eulimella dilleri</i>	639, 640	<i>Helodrilus (Bimastus) gieseleri forma typica</i>	171
<i>gabbiana</i>	639	var. <i>hempeli</i>	172
<i>ochsneri</i>	639	<i>longicinctus</i>	174
<i>Eunice (Leodice) dubia</i>	427	<i>palustris</i>	169
<i>siciliensis</i>	427	<i>parvus</i>	173
<i>Exoprosopa fascipennis</i>	141	<i>tenuis</i>	176
<i>Filinia longiseta</i>	477	<i>tumidus</i>	170
Fisher, Walter K. <i>Trophodiscus</i> , a new sea star from Kamohatka.....	367	<i>zeteki</i>	175
Fishes, fossil, in the collection of the United States National Museum.....	235	<i>caliginosus trapezoides</i>	167
Florisant, Colorado, new species of fossil bee- tles from.....	463	<i>castaneus</i>	180
<i>Floccularia coronetta</i>	477	<i>constrictus</i>	176, 177
<i>cornuta</i>	477	(<i>Dendrobaena</i>) <i>octaedrus</i>	168
<i>ornata</i>	477	<i>rubidus</i> , var. <i>sub-</i> <i>ricunda</i>	168
<i>ringens</i>	477	<i>subrubicundus</i>	168
Fossil beetles from Florissant, Colorado, new species of.....	463	(<i>Eisenia</i>) <i>carolinensis</i>	164
Fossil fishes in the collection of the United States National Museum.....	235	<i>foetidus</i>	165
Fox, Henry. Field notes on Virginia orthop- ters.....	199	<i>lomburgi</i>	164
<i>Fregata minor minor</i>	185	<i>roseus</i>	165
<i>Galeopterus saturatus</i>	459	<i>venetus</i> , var. <i>hortensis</i> ..	166
<i>tuancus</i>	457	(<i>Eiseniella</i>) <i>tetraedrus</i> , forma <i>her-</i> <i>cynia</i>	162
<i>Gallus varius</i>	187	<i>tetraedrus</i> , forma, <i>ty-</i> <i>pica</i>	161
<i>Garmannia spongicola</i>	423	<i>gieseleri</i>	172
Garter snake inhabiting the San Francisco Peninsula, the variation exhibited by <i>Thamnophis ordinoides</i>	345	<i>hempil</i>	171, 172
<i>Geopelia striata</i>	184	<i>typica</i>	172
<i>Gephyura concentrica</i>	290	<i>longicinctus</i>	174
Gidley, James Williams. Notice of a new Paleocene mammal, a possible relative of the <i>Titanotheres</i>	431	<i>longus</i>	167
<i>Glycymeris cortexiana</i>	402	<i>norvegicus</i>	177
<i>miguelliana</i>	402	<i>octaedrus</i>	168
Goby, a new, <i>Garmannia spongicola</i> , from North Carolina.....	423	<i>palustris</i>	169
<i>Gomphus donneri</i>	562, 574	<i>parvus</i>	173, 174
<i>intricatus</i>	560, 554, 570, 622, 624	<i>subrubicundus</i>	169
<i>olivaceus</i>	554, 606, 625, 630	<i>tenuis</i>	176, 177, 178
<i>nevadensis</i>	570, 622, 623, 624	<i>tetraedrus</i>	163, 171
var. <i>nevadensis</i>	557	forma <i>hercynia</i>	161, 163
<i>sohrinus</i>	541, 558, 562, 572, 594, 596, 599, 603, 606	<i>neapolitana</i>	162
<i>Gracula javensis baweanae</i>	195	<i>ninnil</i>	162
<i>javensis</i>	195	<i>typica</i>	161
<i>Gryllus assimilis</i>	233	<i>tumidus</i>	171, 172
<i>Haleyon sanctus</i>	189	<i>venetus hortensis</i>	166
<i>senegalensis</i>	189	<i>welchii</i>	174, 175
<i>Harpacanthus fimbriatus</i>	266	<i>zeteki</i>	175, 176, 178
<i>procumbens</i>	266	<i>Hemigalus minor</i>	460
<i>Harpalus maceratus</i>	465	<i>Heraclides priscus</i>	383
<i>redivivus</i>	463, 465	<i>Hetaerina americana</i>	596,
<i>ulomaeformis</i>	463, 464	597, 601, 603, 604, 606, 607, 627, 629	
<i>Helodrilus</i>	161	<i>Heteracanthus politus</i>	245
(<i>Alloleobophora</i>) <i>caliginosus</i>	166	<i>uddeni</i>	245
<i>f. typica</i>	166	<i>Hippisus rugosus</i>	202, 203, 216
<i>f. trape-</i> <i>zoides</i>	166	<i>Hipposideros larvatus</i>	458
<i>chloroticus</i>	167	<i>sp.</i>	458, 459, 460
<i>longus</i>	167	<i>Holonema rugosa</i>	240
<i>beddardi</i>	173, 174	<i>Homolopsis depressa</i>	389
(<i>Bimastus</i>) <i>beddardi</i>	173	<i>edwardsii</i>	389
<i>constrictus</i>	176	<i>japonica</i>	389
		<i>punctata</i>	388
		<i>richardsoni</i>	389
		<i>transiens</i>	389
		<i>Homocoryphus malivolans</i>	227
		Hymenoptera, Nearctic, monograph of the, of the genus <i>Bracon</i>	305
		<i>Hyponeura lugens</i>	596, 605, 630
		<i>Ichneumon deserti</i>	307
		Insects, Tertiary, new.....	373
		Ischnoptera, species.....	206

	Page.		Page.
<i>Ichnura cervula</i>	505, 504, 506, 599, 600, 601, 605, 608, 610, 612, 617, 618, 619, 620, 622, 623, 625, 627, 629, 630, 633	<i>Libellula forensis</i>	505, 600, 601, 602, 604, 607, 617, 620, 622, 630
<i>demorsa</i>	622	<i>nodisticta</i>	604, 608, 623, 630
<i>denticollis</i>	496	<i>pulchella</i>	505, 604, 608, 610, 612, 618, 621, 623, 626, 630, 634
<i>erratica</i>	594, 632	<i>quadrinaculata</i>	610, 613, 614, 615, 616, 634
<i>perparva</i>	505, 594, 596, 599, 600, 601, 602, 603, 605, 606, 608, 610, 612, 620, 627, 630, 631	<i>saturata</i>	505, 597, 600, 601, 602, 604, 605, 607, 608, 626, 627, 628, 630, 631, 634
<i>pumilo</i>	496	<i>Limatula attenuata</i>	404
<i>Ischypterus elegans</i>	282	<i>Limopsis akutanica</i>	403
<i>modestus</i>	282	<i>skania</i>	402
Java Sea, birds of Bawean Island.....	183	<i>Lithophaga attenuata</i>	405
Kamchatka, <i>Trophodiscus</i> , a new sea star from.....	367	<i>Lophocharis oxyteron</i>	477
Kennedy, Clarence Hamilton. Notes on the life history and ecology of the dragonflies (Odonata) of central California and Nevada.....	483	Los Angeles, California, rotatoria of, with de- scription of a new species.....	473
<i>Keratella cochlearis</i>	475	Lumbricidae, North American earthworms of the family, in the collections of the United States National Museum.....	157
<i>quadrata</i>	475	<i>Lumbricus agricola</i>	180
<i>Kerivoula engana</i>	460	<i>americanus</i>	180
<i>Lanthus albistylus</i>	581	<i>castaneus</i>	179
<i>Laricus obscurus</i>	460	<i>festivus</i>	180
<i>rostratus</i>	459	<i>herculeus</i>	180
<i>Lecane arcuata</i>	475	<i>purpureus</i>	179
<i>aspidia</i>	476	<i>riparius</i>	167
<i>curvicornis</i>	476	<i>rubellus</i>	179
<i>hornemanni</i>	476	<i>terrestris</i>	180
<i>luna</i>	476	<i>var. lacteus</i>	178
<i>Leda amata</i>	395	<i>trapezoides</i>	166
<i>commutata</i>	395	Lyon, Marcus Ward, Jr. Mammals collected by Dr. W. L. Abbott on the chain of islands lying off the western coast of Sumatra, with descriptions of twenty-eight new species and subspecies.....	437
<i>constellata</i>	395	<i>Macacus cynomolgus</i>	453
<i>flavescens</i>	397	<i>fuscus</i>	453
<i>fossa</i>	395	<i>Macoma brota</i>	413
<i>gomphoides</i>	395	<i>var. lipara</i>	414
<i>hamata</i>	397	<i>carlottensis</i>	414
<i>hlogona</i>	395	<i>infistula</i>	414
<i>navisa</i>	395	<i>inquinata</i>	414
<i>oxia</i>	395	<i>quadrana</i>	414
<i>phenaxia</i>	397	<i>truncaria</i>	414
<i>radiata</i>	395	<i>Macrochaetus collinsi</i>	477
<i>spargana</i>	397	<i>Macrogleosus minimus minimus</i>	456
<i>Leo rhionis</i>	445	<i>Macromia magnifica</i>	597, 599, 603, 605, 608, 622, 623, 626, 629
<i>Leodice cariboea</i>	427	<i>Macrophya pervetusta</i>	383
<i>dubia</i>	427	<i>Mactrella clisia</i>	415
<i>Lepadella acuminata</i>	476	<i>exoleta</i>	415
<i>patella</i>	476	<i>Malachius immurus</i>	463, 468
<i>rhomboides</i>	476	<i>Malacocinclia abbotti baweana</i>	194
<i>triptera</i>	477	<i>buttikoferi</i>	194
<i>Lepidotus walcotti</i>	283	<i>Malletia (Minormalletia) talama</i>	400
<i>Leptychaster anomalus</i>	367, 371	<i>(Nello) flora</i>	400
<i>arcticus</i>	371	Mammal, a new Paleocene, a possible relative of the Titanotheres.....	431
<i>kerghuelensis</i>	370	Mammals collected by Dr. W. L. Abbott from islands off Sumatra, with descriptions of twenty-eight new species and subspecies.....	437
<i>pacificus</i>	371	<i>Manis javanica</i>	458, 460
<i>propinquus</i>	367, 371	<i>Megadermas lahe</i>	439, 440, 457
<i>Leptysmia marginicollis</i>	202, 218	<i>nasense</i>	440, 441, 458
<i>Lestes congener</i>	593, 601, 604, 606, 609, 611, 613, 615, 616, 617, 620, 621, 630	<i>stomatilis</i>	439, 440, 457
<i>disjunctus</i>	593, 609, 611, 615, 633	<i>spasma</i>	439
<i>species</i>	596	<i>trifolium</i>	439, 440, 441
<i>stultus</i>	485, 594, 602, 632	<i>Melanella gabbiana</i>	639
<i>uncatus</i>	607, 611, 613, 615, 616, 633		
<i>ungulicatus</i>	594, 621		
<i>Leuciscus turneri</i>	292		
<i>Leucorrhina glacialis</i>	611, 613, 616, 617, 635		
<i>Libellula comanche</i>	603		
<i>composita</i>	632		

	Page.		Page.
<i>Melanoplus atlantis</i>	202, 203, 213, 214, 221	<i>Monedula scitula</i>	46
<i>bivittatus</i>	201, 202, 203, 223	<i>serrata</i>	31
<i>femoratus</i>	223	<i>signata</i>	18
<i>celatus</i>	201, 203, 220	<i>speciosa</i>	27, 41
<i>confusus</i>	201, 202, 203, 223	<i>tenuicornis</i>	36
<i>devius</i>	201, 221	<i>usitata</i>	32, 52
<i>femur-rubrum</i>	201, 202, 214, 223	<i>ventralis</i>	62, 71
<i>gracilis</i>	201, 221	<i>villosa</i>	45
<i>keeleri</i>	202, 223	<i>Mongoma cruciferella</i>	373
<i>luridus</i>	201, 202, 223	<i>fragillima</i>	374
<i>scudderi</i>	202, 220	<i>niveitarsis</i>	374
<i>walshii</i>	201, 221	<i>pallida</i>	374
<i>Melicerta ringens</i>	477	<i>Monostyla bicornis</i>	476
<i>Meliera atavina</i>	379	<i>bulia</i>	476
<i>obsuricornis</i>	379	<i>closteroerca</i>	476
<i>ochricornis</i>	379	<i>cornuta</i>	476
<i>Mermiria intertexta</i>	208	<i>hamata</i>	476
<i>Merrill, George P.</i> A new find of meteoric stones near Plainview, Hale County, Texas.	419	<i>lunaris</i>	475
<i>Mesomyites concinnus</i>	377	<i>quadridentata</i>	476
<i>Meteorites</i> , a new find of, from Plainview, Hale County, Texas.....	419	<i>stenroosi</i>	476
<i>Metopidia oxyteron</i>	477	<i>Morrison, Harold.</i> Monograph of the Nearctic hymenoptera of the genus <i>Bracon</i> Fabricius.	305
<i>Microbembex aurata</i>	121	<i>Motacilla flammea</i>	198
<i>hirsuta</i>	122	<i>Munia punctulata nisorla</i>	184
<i>monodonta</i>	110, 134, 141	<i>Mus fremens</i>	450
<i>Microcentrum laurifolium</i>	226	<i>lingensis</i>	449
<i>retinerve</i>	226	<i>Musculus laevigatus</i>	405
<i>Microtarsus atriceps abbotti</i>	193	<i>niger</i> , var. <i>obesus</i>	405
<i>atriceps</i>	193	<i>protractus</i>	405
<i>chrysophorus</i>	194	<i>olivaceus</i>	405
<i>hyperempus</i>	194	<i>Mycterops orcinatus</i>	270
<i>baweanus</i>	192	<i>Myers, Frank J.</i> Rotatoria of Los Angeles, California, and vicinity, with descriptions of a new species.....	473
<i>chalconcephalus</i>	192	<i>Mylostoma</i>	250
<i>baweanus</i>	192	<i>terrelli</i>	251
<i>Milneria kelseyi</i>	408	<i>variable</i>	250
<i>Modontiscus meridionalis</i>	408	<i>Myonera tillamookensis</i>	407
<i>prolongatus</i>	408	<i>Myotis abbotti</i>	441, 442, 460
<i>Miogryllus verticalis</i>	233	<i>muricola</i>	441, 442
<i>Mioplosus labracoides</i>	294	<i>niassensis</i>	441, 442
<i>Modiolus (Politus) var. pallidulus</i>	404	<i>Mytilina mucronata</i>	475
<i>Mollusks</i> , new species of marine bivalve, from the northwest coast of America in the collection of the United States National Museum.....	393	<i>ventralis</i>	475
West American marine, descrip- tions of new.....	637	<i>Nemobius fasciatus</i>	233
<i>Monedula carolina</i>	20	<i>maculatus</i>	234
<i>denverensis</i>	25	<i>Neooncephalus ensiger</i>	201, 226
<i>emarginata</i>	38	<i>exiliscanorus</i>	202, 226
<i>exigua</i>	50	<i>lyristes</i>	202, 226
<i>femorata</i>	53	<i>melanorhinus</i>	202, 226
<i>formosa</i>	21, 27	<i>palustris</i>	202, 227
<i>inermis</i>	25	<i>retusus</i>	202, 227
<i>mamillata</i>	38, 45	<i>robustus</i>	202, 227
<i>melampous</i>	43	<i>crepitans</i>	227
<i>minutula</i>	40	<i>triops</i>	202, 227
<i>nigrifrons</i>	119	<i>Neotettix femoratus</i>	207
<i>obliqua</i>	12	Nevada and central California, notes on the life history and ecology of the dragonflies of.	483
<i>parata</i>	64	<i>Nomonyx dominicus</i>	483
<i>pictifrons</i>	25	North Carolina, a new goby, <i>Garmannia spon-</i> <i>giola</i> , from.....	423
<i>plana</i>	32	<i>Notagodus decoratus</i>	287
<i>pulchella</i>	40	<i>inimontis</i>	287
<i>pulla</i>	52	<i>minutus</i>	287
<i>quadrifasciata</i>	65, 67	<i>Notus quadricornis</i>	475
<i>sallei</i>	65	<i>Notholen striata</i>	475
		<i>Notogoneus osculus</i>	289

	Page.		Page.
<i>Notommata cerberus</i>	474	Orthoptera, field notes on Virginia.....	199
<i>pachyura</i>	474	<i>Orthotomus cinereus</i>	184
<i>tripus</i>	474	<i>Pachydiplax longipennis</i>	595,
<i>Nucula cardara</i>	394	602, 604, 628, 630, 631, 638	
<i>darella</i>	394	<i>Palaeaspis americana</i>	239
<i>linki</i>	394	<i>bitruncata</i>	239
<i>petriola</i>	395	<i>elliptica</i>	239
<i>quirica</i>	394	<i>Palaeoniscus antiquus</i>	273
Oberholser, Harry C., The birds of Bawean		<i>reticulatus</i>	273
Island, Java Sea.....	183	<i>Palaeophichthys parvulus</i>	272
<i>Oecophylla atavina</i>	382	Panama, a new species of polychaetous anne-	
<i>Octogomphus specularis</i>	516,	lid from, with notes on an Hawaiian form.....	427
574, 594, 595, 598, 599, 605, 608, 630, 632		<i>Pandelestus nudus</i>	463, 470
<i>Ocotilium lacteum</i>	178	<i>submetallicus</i>	471
<i>Odonata</i> of central California and Nevada,		<i>Panomyia arctica</i> , var. <i>turgida</i>	416
notes on the life history and ecology of the.....	482	<i>beringiana</i>	416
<i>Odotomia</i> (<i>Chrysallida</i>) <i>santamariensis</i>	664	<i>Pantala hymenaea</i>	628
<i>taravali</i>	663	<i>Paradoxurus hermaphroditus</i>	442
(<i>Evalea</i>) <i>andersoni</i>	667	<i>enganus</i>	442
<i>franciscana</i>	665	<i>parvus</i>	442, 443, 457
<i>orfordensis</i>	667	<i>lignicolor</i>	460
<i>pleioregona</i>	666	<i>Parafundulus nevadensis</i>	291
<i>stephensi</i>	667	<i>Pardalophora apiculata</i>	201, 202, 203, 215
<i>valensi</i>	667	<i>phoenicoptera</i>	202, 203, 215
<i>valerol</i>	665	Parker, John Bernard. A revision of the Bem-	
<i>willetti</i>	666	bicline wasps of America north of Mexico.....	1
(<i>Odotomia</i>) <i>orcutti</i>	667	<i>Paroxya clavuliger</i>	202, 203, 224
<i>stephensi</i>	667	<i>Pedalia mira</i>	477
<i>Oecanthus angustipennis</i>	234	<i>Pedalion mirum</i>	477
<i>latipennis</i>	234	<i>Pelecanus minor</i>	185
<i>nigricornis</i>	234	<i>Peltacanthus</i> (?) <i>occidentalis</i>	261
<i>quadripunctatus</i>	234	<i>Petaurista batwana batwana</i>	459
<i>Oedistes crystallinus</i>	477	<i>Phastinus varius</i>	187
<i>mucicola</i>	477	<i>Pholadidea sagitta</i>	417
<i>umbella</i>	477	<i>Phyllodoce panamensis</i>	428
<i>velatus</i>	477	<i>Physonemus acinaciformis</i>	263
<i>Oldemia fusca</i>	482	<i>anceps</i>	263
<i>nigra</i>	479, 482	<i>arcuatus</i>	263, 264
<i>Ophiogomphus arizonicus</i>	538	<i>asper</i>	263
<i>bison</i>	525,	<i>bauciformis</i>	263
540, 547, 595, 598, 603, 605, 631, 632		<i>gemmatus</i>	263
<i>morrisoni</i>	530,	<i>gigas</i>	263
534, 535, 548, 562, 612, 614, 617, 633		<i>hamus-piscatorius</i>	263
<i>nevadensis</i>	536,	<i>mirabilis</i>	263
549, 618, 620, 622, 633		<i>nectis</i>	263
<i>occidentis</i>	541, 542, 547	<i>pendatus</i>	263
<i>californicus</i>	543,	<i>stellatus</i>	263
547, 601, 603, 606, 608		<i>Pipistrellus macrotis</i>	460
<i>severus</i>	531, 548	<i>Pithecius agnatus</i>	458
<i>montanus</i>	530, 533	<i>fascicularis</i>	452, 459
<i>Ops glaberrima</i>	380	<i>fuscus fuscus</i>	457
<i>Oracanthus milleri</i>	268	<i>lasia</i>	453, 457
<i>rectus</i>	268	<i>mansalis</i>	452, 458
<i>triangularis</i>	268	<i>pagensis</i>	460
<i>vetustus</i>	267, 268	<i>phaeura</i>	458
<i>Orchelimum agile</i>	202, 228	Platview, Hale County, Texas, a new find of	
<i>concinnum</i>	202, 230	meteoric stones near.....	419
<i>fidicinum</i>	202, 230	<i>Platthemis lydia</i>	595, 597,
<i>glaberrimum</i>	202, 228	600, 601, 602, 604, 607, 608, 610, 626, 628, 630, 634	
<i>laticauda</i>	202, 229	<i>subornata</i>	623, 632
<i>minor</i>	202, 229	<i>Platylas quadricornis</i>	475
<i>superbum</i>	202, 230	<i>Platynus insculptipennis</i>	463
<i>vulgare</i>	229	<i>tartareus</i>	464
<i>Orocharis saltator</i>	202, 234	<i>Platysomus circularis</i>	276
<i>Orphulella olivacea</i>	202, 210	<i>lacovianus</i>	276
<i>pelinda</i>	202, 210, 213	<i>orbicularis</i>	276
<i>speciosa</i>	210	<i>palmaris</i>	276

	Page.		Page.
<i>Plecia explanata</i>	376	Rathbun, Mary J. New species of South	
<i>fulvicollis</i>	375	Dakota cretaceous crabs.....	385
<i>winchesteri</i>	375	<i>Rattulus longicauda</i>	477
<i>woodruffi</i>	375	<i>scipio</i>	477
<i>Pleurotrocha daphnicola</i>	473, 478	<i>Rattus balmasus</i>	447, 448, 459
<i>petromyzon</i>	474	<i>barussanus</i>	458
<i>sigmoidea</i>	478	<i>batus</i>	458, 459
<i>Plioplarhus septemspinus</i>	295	<i>catellifer</i>	458
<i>sexspinus</i>	295	<i>concolor concolor</i>	458
<i>whitiei</i>	295	<i>domitor</i>	458
<i>Ploecus manyar</i>	184	<i>enganus</i>	460
<i>Podabrus cupesoides</i>	463, 467	<i>firms</i>	448
<i>Polyarthra platyptera</i>	477	<i>fremens fremens</i>	452
<i>trigla</i>	477	<i>mansalaris</i>	450, 452, 458
<i>Polynemidium pustulosum</i>	387	<i>tuancus</i>	452, 458
<i>Polyrhisodus concavus</i>	257	<i>lingensis</i>	449, 450
<i>grandis</i>	257	<i>antucus</i>	449, 458
<i>Priscacara cypha</i>	296	<i>banacus</i>	449, 457, 459
<i>dartonae</i>	296	<i>mabalus</i>	449, 459
<i>liope</i>	296	<i>pinacus</i>	450
<i>oxyprion</i>	296	<i>lugens</i>	460
<i>pealei</i>	296	<i>maerens</i>	458
<i>serrata</i>	296	<i>masae balae</i>	459
<i>testudinaria</i>	296	<i>masae</i>	459
<i>Proales daphnicola</i>	474, 478	<i>neglectus</i>	460
<i>decipiens</i>	474	<i>pagensis</i>	460
<i>Progomphus borealis</i>	524, 527, 596, 606, 630	<i>pinatus</i>	448, 459
<i>obscurus</i>	525, 527	<i>potans</i>	458
<i>Prolepidotus gallineki</i>	279	<i>simalurensis babi</i>	447
<i>Protocardia pasiana</i>	412	<i>simalurensis</i>	446, 457
<i>Protoscinis</i>	380	<i>soccatus</i>	460
<i>perparvus</i>	380	<i>valens</i>	457
<i>Protothaca staminea</i> , var. <i>spatiosa</i>	413	<i>voctierans tapanulius</i>	461
<i>Psammodus glyptus</i>	258	<i>Ratufa balae balae</i>	459
<i>plenus</i>	258	<i>masae</i>	459
<i>springeri</i>	258	<i>pinensis</i>	459
<i>Psammosteus</i>	241	<i>nigrescens</i>	458
<i>imperfectus</i>	242	<i>pallata</i>	445
<i>paradoxus</i>	241, 242	<i>batuana</i>	445, 446, 459
<i>taylori</i>	239, 241	<i>laenata</i>	446, 458
<i>Psaphidia brunnea</i>	413	<i>Rhadinichthys deani</i>	273
<i>Psaphodus legrandensis</i>	259	<i>gracilis</i>	274
<i>Pseudamium bistriatum</i>	404	<i>Rhamphomyia hypolitha</i>	378
<i>incongruum</i>	403	<i>sepulta</i>	378
<i>Pseudopythina myciformis</i>	412	<i>Rhinolophus calyseo</i>	400
<i>Painidia fenestralis</i>	202, 217	<i>circe</i>	458
<i>Pteria viridizona</i>	403	<i>trifolatus niasensis</i>	458
<i>Pterodina patina</i>	477	<i>Rhinosciurus incultus</i>	444, 445, 458
<i>Pteropus hypomelanus enganus</i>	460	<i>laticaudatus</i>	444
<i>modigliani</i>	460	<i>leo</i>	444
<i>niadicus</i>	458	<i>persaer</i>	444
<i>vampyrus malaccensis</i>	460	<i>rhonis</i>	444
<i>Ptilocercus lowii continentalis</i>	459	<i>robinsoni</i>	444
<i>Ptygura crystallina</i>	477	<i>tupaloides</i>	444
<i>longipes</i>	477	<i>Rhipidia brodiei</i>	373
<i>mucicola</i>	477	<i>Rissoina dalli</i>	679
<i>velata</i>	477	<i>histia</i>	679
<i>Pycnonotus plumosus</i>	191	<i>kelseyi</i>	679
<i>plumosus</i>	191	<i>neraina</i>	679
<i>Pygathrix batuana</i>	459	<i>Rochefortia beringensis</i>	411
<i>potenziani</i>	460	<i>ferruginosa</i>	411
<i>Pyramidella (Longchaeus) cooperi</i>	637	<i>goltschi</i>	411
<i>mazatlanica</i>	639	<i>grebnitskii</i>	411
<i>pecki</i>	638	<i>Rotatoria of Los Angeles, California, and vic-</i>	
<i>(Pharicidella) magdalenensis</i>	638	<i>inity, with descriptions of a new species</i>	473
<i>(Byrrola) dillieri</i>	640	<i>Rusa equina</i>	458, 460
<i>ochsneri</i>	639	<i>Sagenodus angustus</i>	247
<i>Radcliffe, Lewis. Description of a new goby</i>		<i>Salpina mucronata</i>	475
<i>Garmannia spongicola</i> , from North Caro-		<i>ventralis</i>	475
<i>lina</i>	423		

	Page.		Page.
<i>Sandalodus occidentalis</i>	260	<i>Stictiella bituberculata</i>	36
San Francisco Peninsula, the variation exhibited by <i>Thamnophis ordinoides</i> , a garter snake inhabiting the.....	345	<i>callista</i>	34
<i>Sauripterus taylori</i>	252	<i>divergens</i>	55
<i>Sauropatis chloris cyaneescens</i>	189	<i>emarginata</i>	38
<i>Saxicavella pacifica</i>	416	<i>exigua</i>	50
<i>Saxidomus giganteus</i>	413	<i>femorata</i>	53
<i>Scaridium longicaudum</i>	477	<i>formosa</i>	27
<i>Schistocerca alutacea</i>	202, 219	<i>megacera</i>	49
<i>damnifica</i>	202, 219	<i>melampous</i>	43
<i>obscura</i>	202, 220	<i>melanosterna</i>	30
<i>serialis</i>	202, 218	<i>pictifrons</i>	25
<i>Sciuropterus maerens</i>	460	<i>plana</i>	32
<i>Sclurus atratus</i>	460	<i>pulchella</i>	40
<i>balae</i>	459	<i>pulla</i>	51, 52
<i>ictericus</i>	459	<i>scitula</i>	46
<i>mansalaris</i>	444	<i>serrata</i>	31
<i>bancarus</i>	444, 457	<i>speciosa</i>	41
<i>batus</i>	443, 459	<i>tanulicornis</i>	47
<i>mansalaris</i>	458	<i>villosa</i>	45
<i>pinlensis</i>	459	<i>Strix baweana</i>	190
<i>pretiosus</i>	457	<i>orientalis</i>	191
<i>pumilus</i>	460	<i>orientalis</i>	191
<i>saturatus</i>	458	<i>seloputo</i>	190
<i>ubericolor</i>	457	<i>sinensis</i>	191
<i>Scudderella cuneata</i>	202, 225	Sumatra, mammals collected by Dr. W. I. Abbott from islands off.....	437
<i>curvicauda</i>	225	<i>Sus babi</i>	453, 464
<i>furcata</i>	225	<i>babi</i>	454, 457
<i>pectillata</i>	201, 224	<i>enganus</i>	464, 460
<i>texensis</i>	224	<i>tuancus</i>	453, 454, 458
Sea star, <i>Trophodiscus</i> , a new, from Kamchatka.....	367	<i>minus</i>	457
<i>Seminotus carpensis</i>	279	<i>niadensis</i>	458
<i>elegans</i>	282	<i>vittatus</i>	453
<i>Septifer bifurcatus</i> var. <i>obsoletus</i>	404	<i>Sympetrum cordulegaster</i>	521
<i>Simias concolor</i>	460	<i>corruptum</i>	595,
<i>Sisyrha(?) disrupta</i>	381	597, 600, 601, 602, 604, 607, 613, 615, 617,	
<i>vicaria</i>	381	618, 620, 621, 623, 626, 628, 630, 631, 634	
Smith, Frank, North American earthworms of the family Lumbricidae in the collections of the United States National Museum.....	157	<i>costiferum</i>	617, 623
<i>Somatochlora semicircularis</i>	614, 615, 634	<i>eroticum</i>	521
<i>Spharagemon bolli</i>	201, 216	<i>frequens</i>	521
<i>collare wyomingianum</i>	217	<i>flotum</i>	595, 597,
<i>saxatile</i>	201, 203	600, 601, 602, 604, 606, 626, 628, 630	
<i>planum</i>	216	<i>madidum</i>	595, 621
<i>Sphenia trunculus</i>	415	<i>matutinum</i>	521
<i>pholadidea</i>	415	<i>obtrusum</i>	610, 615, 616
<i>Spilopelia tigrina</i>	188	<i>pallipes</i>	607, 610,
<i>Spilornis bassus bassus</i>	185	613, 614, 615, 617, 618, 621, 623, 635	
<i>baweanus</i>	185	<i>rubicundulum decusum</i>	617, 621, 634
<i>Spondylis tertiaris</i>	463, 469	<i>scoticum</i>	610, 613, 614, 617, 635
<i>Squatinella mutica</i>	477	<i>semicinctum</i>	607, 609,
<i>Stagnomantis carolina</i>	202, 207	618, 623, 624, 626, 632	
<i>Steniolia albicantia</i>	12	<i>Symphalangus klossi</i>	460
<i>duplicata</i>	10	<i>Synchaeta oblonga</i>	477
<i>edwardsii</i>	10	<i>pectinata</i>	477
<i>nigripes</i>	8	<i>stylata</i>	477
<i>obliqua</i>	12	<i>tremula</i>	477
<i>scolopacea</i>	10	<i>Syrbula admirabilis</i>	202, 206
<i>sulfurea</i>	9	<i>Systropus foenoides</i>	376
<i>tibialis</i>	14	<i>Tachopteryx</i>	506
<i>Stephanops muticus</i>	477	<i>hageni</i>	507, 508
<i>Stictia carolina</i>	20	<i>pryeri</i>	507, 508
<i>signata</i>	18	<i>thoreyi</i>	508, 513
		<i>Taeniurites</i>	382
		<i>fortis</i>	383
		<i>Tana cervicalis cervicalis</i>	459
		<i>masae</i>	459

	Page.
<i>Tana tana tuancus</i>	457
<i>Tanypteryx</i>	507
<i>hageni</i>	508
<i>pryeri</i>	511
<i>Taphrocampa annulosa</i>	474
<i>Telebasis salva</i>	502, 594, 602, 608, 627, 631
<i>Tellina edentula</i>	413
<i>lata</i>	413
<i>Testudinella patina</i>	477
<i>Tetragoneuria canis</i>	599
<i>spinigera</i>	612
<i>Tetragonurus pupa</i>	163
<i>Tettigidea lateralis</i>	207
<i>Thalassornis insularis</i>	482
<i>leuconatus</i>	482
<i>Thamnophis ordinoides</i> , a garter snake inhabiting the San Francisco peninsula, the variation exhibited by.....	345
<i>ordinoides</i>	365, 366
<i>parietalis</i>	365
Thompson, Joseph C. The variation exhibited by <i>Thamnophis ordinoides</i> (Baird and Girard), a garter snake inhabiting the San Francisco peninsula.....	345
<i>Thyasira cygnus</i>	409
<i>tricarinata</i>	409
<i>Thyestes verrucosus</i>	238
<i>Tindaria brunnea</i>	401
<i>californica</i>	400
<i>cervola</i>	402
<i>dicofania</i>	401
<i>martiniana</i>	401
<i>ritteri</i>	401
<i>Tipula gardneri</i>	374
<i>Titanoidea</i>	431
<i>primaevus</i>	431, 433, 435
Titanotheres, notice of a new Paleocene mammal, a possible relative of the.....	431
<i>Tragus amoenus</i>	458
<i>batuanus</i>	459
<i>brevipes</i>	457
<i>jugalris</i>	458
<i>napu</i>	455
<i>napu</i>	455
<i>niasis</i>	455, 458
<i>pinus</i>	455, 459
<i>russulus</i>	455, 456, 457, 458
<i>masae</i>	456, 457, 459
<i>russulus</i>	459
<i>Tramea lacerata</i>	505, 604, 607, 631
Treadwell, Aaron L. A new species of polychaetous annelid from Panama, with notes on an Hawaiian form.....	427
<i>Triarthra longiseta</i>	477
<i>Trichocerca longiseta</i>	477
<i>scipio</i>	477
<i>Tricophanes foliarum</i>	294
<i>Trichotria pocillum</i>	477
<i>tetractis</i>	477
<i>Trigoniocardia exdoxia</i>	412
<i>Trimerotropis citrina</i>	202, 217
<i>maritima</i>	202, 218
<i>Trophodiscus</i> , a new sea star from Kamchatka.....	367
<i>almus</i>	367, 368
<i>Truxalis brevicornis</i>	202, 207

	Page.
<i>Tupaia chrysogaster</i>	460
<i>tephura</i>	459
<i>Turbonilla (Cingulina) urdeneta</i>	660
(<i>Mormula</i>) <i>sebastiani</i>	661
<i>viscalnoi</i>	663
(<i>Pyrgisculus</i>) <i>gulleni</i>	648
(<i>Pyrgiscus</i>) <i>almejasensis</i>	652
<i>auricoma</i>	653
<i>baegerti</i>	658
<i>bartolomensis</i>	653
<i>cabrilloi</i>	659
<i>corsoensis</i>	657
<i>cortez</i>	656
<i>dora</i>	649
<i>eva</i>	651
<i>ina</i>	649
<i>ista</i>	650
<i>lamna</i>	653
<i>lazarcoensis</i>	655
<i>mariana</i>	654, 655
<i>tecalco</i>	656
<i>ulloa</i>	659
(<i>Pyrgolampro</i>) <i>franciscana</i>	645
<i>hannibali</i>	645
<i>hemphilli</i>	646
<i>lituyana</i>	645
<i>oregonensis</i>	645
<i>pugetensis</i>	647
<i>tremperi</i>	647
(<i>Strioturbonilla</i>) <i>barkleyensis</i>	641
<i>canadensis</i>	640
<i>doredona</i>	642
<i>humerosa</i>	644
<i>montezuma</i>	640
<i>panamensis</i>	645
<i>redondoensis</i>	643
<i>santamariana</i>	642
<i>schmitti</i>	644
<i>serae</i>	642
(<i>Ugarte</i>) <i>juani</i>	662
<i>Tychius evolatus</i>	471
<i>ferox</i>	463, 471
<i>Uracis oviposatrix</i>	521
<i>Urotales</i>	378
<i>caudatus</i>	379
<i>Vespa signata</i>	15
Virginia, field notes on orthoptera in.....	199
<i>Villettea monstrosa</i>	463, 468
<i>murrayi</i>	468
<i>plumbea</i>	468
<i>Vulsella pacifica</i>	403
Wasps, Bembicine, of America north of Mexico, a revision of the.....	1
Wetmore, Alexander. On certain secondary sexual characters in the male ruddy duck, <i>Eristamora jamaicensis</i> (Gmelin).....	479
Wickham, H. F. New species of fossil beetles from Florissant, Colorado.....	463
<i>Wolga spinifera</i>	477
<i>Yoldia beringiana</i>	399
<i>capa</i>	400
<i>cecinnella</i>	399
<i>oleacina</i>	398
<i>orca</i>	399
<i>sanesia</i>	399
<i>secunda</i>	398
<i>thraciaciformis</i>	398
<i>Zoniagrion</i>	488
<i>exclamationis</i>	594, 596, 597, 601, 605, 632

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